ADVANCED ENERGY®

A POWERFUL ADVANTAGE™

Advanced Energy® PVP250kW and PVP260kW Inverters

Installation and Operation

User Manual

June 2012 570-1001792-05A

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Read this entire manual and all other publications pertaining to the work to be performed before you install, operate, or maintain this equipment. Practice all plant and product safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. All personnel who work with or who are exposed to this equipment must take precautions to protect themselves against serious or possibly fatal bodily injury.

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AVERTISSEMENT :

Lire ce manuel au complet ainsi que toutes les autres publications portant sur le travail à effectuer avant d'installer, d'utiliser ou d'entretenir cet équipement. Pratiquer toutes les instructions et précautions de sécurité pour l'usine et les produits. Tout manquement aux instructions suivantes peut provoquer des blessures corporelles et/ou des dommages matériels. Si l'équipement est utilisé de manière non spécifiée par le fabricant, la protection fournie par l'équipement peut être compromise. Tous les membres du personnel travaillant sur cet équipement ou qui y sont exposés doivent observer les précautions pour se protéger contre des blessures graves, voire mortelles.

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Toute utilisation de cette unité PVP250kW/PVP260kW qui n'est pas expressément autorisée dans ce guide de l'utilisateur ou dans la documentation connexe, y compris, sans s'y limiter, l'utilisation de l'unité PVP250kW/PVP260kW avec des technologies de panneaux photovoltaïques incompatibles, est expressément interdite par AE, et AE décline toute responsabilité découlant d'un tel usage interdit. L'unité PVP250kW/ PVP260kW doit seulement être manipulée, installée, utilisée et entretenue par un personnel formé.

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- invertersupport@aei.com

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Safety and Product Compliance Guidelines

IMPORTANT SAFETY INSTRUCTIONS

To ensure safe installation and operation of the Advanced Energy PVP250kW/ PVP260kW unit, read and understand this manual before attempting to install and operate this unit. At a minimum, read and follow the safety guidelines, instructions, and practices.

SAVE THESE INSTRUCTIONS

This manual contains important instructions for the PVP250kW/PVP260kW unit that shall be followed during installation and maintenance of the unit.

DANGER, WARNING, AND CAUTION BOXES IN THE MANUAL

This symbol represents important notes concerning potential harm to people, this unit, or associated equipment. Advanced Energy includes this symbol in Danger, Warning, and Caution boxes to identify specific levels of hazard seriousness.

DANGER:

DANGER indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. DANGER is limited to the most extreme situations.

DANGER:

DANGER indique une situation dangereuse imminente qui, si elle n'est pas évitée, pourrait provoquer la mort ou des blessures graves. DANGER est réservé aux situations les plus extrêmes.

WARNING:

WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury, and/or property damage.

AVERTISSEMENT:

AVERTISSEMENT indique une situation potentiellement dangereuse qui, si elle n'est pas évitée, pourrait provoquer la mort ou des blessures graves et/ou des dommages matériels.

CAUTION:

CAUTION indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury, and/or property damage. CAUTION is also used for property-damage-only accidents.

ATTENTION:

ATTENTION indique une situation potentiellement dangereuse qui, si elle n'est pas évitée, pourrait provoquer des blessures mineures ou modérées et/ou des dommages matériels. ATTENTION est également utilisé pour des accidents causant uniquement des dommages matériels.

SAFETY GUIDELINES

Review the following information before attempting to install and operate the product.

Rules for Safe Installation and Operation

Please note the following rules:

- Do not attempt to install or operate this equipment without proper training.
- Ensure that this unit is properly grounded.
- Ensure that all cables are properly connected.
- Verify that input line voltage and current capacity are within specifications before turning on the power supplies.
- Use proper electrostatic discharge (ESD) precautions.
- Always be careful around this equipment.

PERSONAL SAFETY

Ensure any personnel entering a safety zone within a four foot area around any operating inverter wear appropriate Personal Protective Equipment (PPE) as mandated by national, state, and local authorities.

Medical and First Aid Treatment

Personnel working in and around operating power generation equipment should be trained in Arc Flash Hazard, Fire Extinguisher selection and use, First Aid, Cardio Pulmonary Resuscitation (CPR), and Automated External Defibrillator (AED) use (if available).

Safety Equipment Requirements

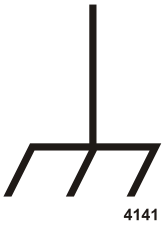
Authorized service personnel performing operations on this unit should have the following minimum safety equipment available:

- Consult NFPA 70E, or applicable local standards, for PPE requirements on switch gear operating at less than 600 V
- Electrical hazard footwear (ANSI Z41/Z85 rated)
- Lock Out Tag Out (LOTO) Kit
- Appropriate meter to verify the circuits are safely de-energized (1000 VAC and DC rated, minimum)
- Any other equipment as applicable to your operation as required by national, state, and local regulations

INTERPRETING PRODUCT LABELS

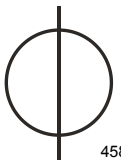
The following labels may appear on your unit:

Earth ground



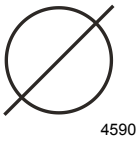
Chassis ground

On or off



or

Phase

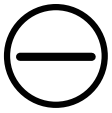


Electrical fuse

Alternating current

Direct current

Positive



Negative

PRODUCT COMPLIANCE

The following sections include information about unit compliance and certification, including the conditions of use required to be in compliance with the standards and directives.

Safety and EMC Directives and Standards

Certain options of this unit have been tested for and comply with the following electromagnetic compatibility (EMC) and safety directives and standards and industry guidelines.

☞ **Important**

This equipment must be installed and used in accordance with the Conditions of Use described in this manual. If this equipment is expanded, modified, or installed into a larger system, the user is responsible to guarantee the compliance of the overall system. If this equipment is used with external components, the user must ensure that the Safety and EMC requirements are not violated.

SAFETY DIRECTIVES AND STANDARDS

- **UL1741**

  Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources (2010)

  - **IEEE 1547**

    Standard for Interconnecting Distributed Resource with Electric Power Systems

  - **IEEE 1547.1**

    Standard for Conformance Tests Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems

- **FCC Part 15 Class A** conducted emissions
- **CSA C22.2 No. 107.1-01**

  General use power supplies—industrial products

- **National Electrical Code**

  Can be installed in compliance with National Electrical Code 2008 and 2011 Editions Article 690 Solar Photovoltaic Systems

Electrical Safety

DISCONNECT SWITCHES

The inverter is equipped with both AC and DC disconnects (power OFF) to stop power conversion within the inverter. Before accessing the interior of the cabinet, these disconnects must be in the OFF position. Since these disconnects only stop power conversion within the inverter, both the DC (photovoltaic array) and AC (utility grid) circuits must be isolated in order to fully ensure the inverter is de-energized. Wait five minutes for the inverter to de-energize before working on the inverter.

Wiring Requirements

You must meet the following requirements when wiring the PVP250kW and PVP260kW inverters:

Table 1-1. Branch breaker size recommendations

Model	208 VAC	480 VAC	600 VAC
PVP250kW	N/A	400 A	350 A
PVP260kW	N/A	400 A	N/A
PVP260kW-LV	N/A	400 A	N/A

WIRING INFORMATION

Important

You must use National Electrical Code (ANSI/NFPA 70) wiring methods.

DANGER:

Do not connect the PV negative or positive conductors to the ground bus bars provided. The PV array is grounded through the integral GFDI. Connecting the PV array positive or negative conductors to ground at any other point in the system would defeat the ground fault protection circuit.

DANGER:

Ne pas brancher les conducteurs négatifs ou positifs du PV aux barres omnibus mises à la terre fournies. Le panneau photovoltaïque est mis à la terre au moyen du GFDI. La connexion des conducteurs positifs ou négatifs du panneau photovoltaïque à la terre à tout autre point du système pourrait déjouer le circuit de protection contre les défauts de terre.

- All wiring methods and materials shall be in accordance with the National Electrical Code ANSI/NFPA 70 as well as all state and local code requirements.
- When sizing conductors and conduits for connection to the PVP250kW and PVP260kW inverters, both shall be in accordance with the National Electrical Code ANSI/NFPA 70, as well as state and local code requirements.
- The AC power conductor bus bar connections in the inverter should be tightened to the torque value specified in the installation instructions. Each conductor should be connected separately to the bus bar.
- The DC power conductor bus bar connections in the inverter should be tightened to the torque value specified in the installation instructions. Each conductor should be connected separately to the bus bar.
- AC overcurrent protection for the utility interconnect (grid-tie) must be provided by the installers as part of the inverter installation.

- Installations in Canada should be in accordance with the Canadian Electrical Code (CEC) or applicable local standards.
- Use only conductors with an insulation rating of 90°C minimum insulation rating.
- This equipment is intended to be installed as part of a permanently grounded electrical system per the NEC or local standards.

The inverter is electrically connected to the DC photovoltaic array in the DC combiner sub panel which includes a positive, negative, and grounded bus bar. The PV array is grounded internally by means of the GFDI.

The inverter can be ordered with an optional fused subcombiner. The fused subcombiners have individual input terminals for each fuse block. These terminals require the use of a torque wrench to properly install the interface cables. Use proper torque values of DC subcombiner box wire mounting hardware.

The inverter is factory configured for the appropriate three-phase output:

- PVP250kW and PVP260kW three-phase 480 VAC or three-phase 600 VAC output

The inverter is electrically connected to the utility grid at the AC landing within the AC section on the front right side of the inverter. These terminals require the use of a UL-approved connector certified for use with the selected interface cables:

- Crimp-on type ring terminal
- Compression type lug

Ensure phase cables run together through conduit and gland plates, which allows any inductive currents produced to be cancelled out. Use proper torque values for terminal lug mounting hardware.

A copper clad earth grounding electrode must be installed within three feet (one meter) of the unit. The AC ground busbar located in the AC section, lower front compartment, must be used as the single point connection to the earth grounding electrode for the inverter system. For the convenience of installers, a DC ground bus bar is provided. The DC and AC ground bus bars are solidly bonded together inside the cabinet. If present, a DC Grounding Electrode Conductor (GEC) may be bonded to the DC ground bar. Where permitted by NEC, a single conductor that meets all the requirements of both DC GEC and AC equipment ground may be bonded to the AC ground bar.

AC overcurrent protection for the utility interconnect (grid-tied) must be provided by installers as part of the installation.

Fire Prevention

Care must be exercised when installing DC and AC connections within the inverter. Follow all instructions in this manual to ensure proper and safe operation of this unit.

DANGER:

Risk of electrical shock. In the event of a fire, disconnect power to the inverter and do not attempt to use a water based fire extinguisher. Utilize only a Class C extinguisher rated for electrical fire.

DANGER:

Risque d'électrocution. Dans l'éventualité d'un incendie, débranchez l'onduleur du secteur et n'utilisez pas d'extincteur à base aqueuse. Utilisez uniquement les extincteurs de classe C conçus pour combattre les feux électriques.

LOCKOUT AND TAGOUT REQUIREMENTS

To prepare the PVP250kW/PVP260kW unit for maintenance or troubleshooting, you must de-energize and isolate the AC and the DC interface energy sources before working on the unit.

ACRONYMS AND FREQUENTLY USED TERMS

Table 1-2. Acronyms and frequently used terms

Term	Description
Action delay	A predefined delay before a set point change.
A/D	Analog to digital conversion
ANSI	American National Standards Institute
BEMS	Building energy management system
CFM	Cubic feet per minute
Curtailment	A reduction of the power output level for scheduled capacity or energy delivery. Allows limiting of system output power. Also known as power throttling.
DHCP	Dynamic host configuration protocol
DNS	Domain name service
DSP	Digital signal processor
DVI	Digital video interface

Table 1-2. Acronyms and frequently used terms (Continued)

Term	Description
EMI	Electromagnetic interference
ESD	Electro static discharge
GEC	Grounding electrode conductor
GFDI	Ground fault detector interruptor
IEEE	Institute of Electrical and Electronics Engineers
IGBT	Insulated gate bipolar transistor
Inverter	Also called the switching section or engine, this is the part of the unit that inverts DC current to AC current.
IP	Internet protocol
Lagging	Current follows, or lags, voltage in an inductor. A source producing power with a lagging power factor reduces the utility grid voltage.
Leading	Current leads the voltage in a capacitor. A source producing power with a leading power factor increases the grid voltage.
LOTO	Lockout Tagout
MCM	1000 circular mils utilized in wire sizing
MPPT	Maximum power point tracking
NEC	National Electric Code
NFPA	National Fire Protection Association
NTP	Network time protocol
OEM mode	Original equipment manufacturer mode
PCB	Printed circuit board
PF	Power factor
PLL	Phase lock loop
PPE	Personal protective equipment
PV	Photovoltaic
PVM	PV monitoring
PVM Sync	Software application used to query inverters.
PWM	Pulse width modulation
Ramp rate	Changes in the inverter's power output at a controlled rate either to increase or decrease power delivery.
Randomize	Allows a random delay before a set point change. The delay will change every set point change.
Remote enable/ disable	The inverter system can be remotely turned on or off. The inverter restarts after a five minute countdown.
RMS	Root mean squared

Table 1-2. Acronyms and frequently used terms (Continued)

Term	Description
SCADA	Supervisory control and data acquisition. A computer system that monitors and controls infrastructure or facility-based processes.
Set point	Inverter is operating and delivering power at defined parameters.
UL	Underwriter's Laboratory
UTC	Universal time coordinate. Also known as Greenwich mean time.
VAC	Voltage alternating current
VDC	Voltage direct current
VFD	Vacuum fluorescent display
Voc	Open-circuit voltage

Chapter 2

Product Overview

GENERAL DESCRIPTION

The Advanced Energy inverter is designed to act exclusively as a grid-tied inverter for photovoltaic (PV) systems. The inverter converts direct current (DC) electricity generated by the photovoltaic arrays into usable alternating current (AC) electricity. This means the inverter must be tied to the utility grid and a photovoltaic system in order to operate properly. Because the inverter is tied to a local utility source, if local electrical load exceeds the power generated by the solar array, the grid automatically supplies the additional electricity needed. Likewise, if the inverter produces more power than is needed, it feeds the excess power back into the electrical grid.

Advanced Energy Inverter Models

This manual provides the information necessary to successfully install and operate the applicable Advanced Energy inverter.

Within the AE product line some inverter models can be factory configured with different three-phase outputs. For specific product characteristics, refer to the specifications in Appendix A.

Specific inverter models are available in two configurations. The PVP260kW is available with standard VDC input and low voltage VDC input. All other specifications are identical.

DESIGN FEATURES

- Easy installation: The AE inverter is built for easy installation. To minimize installation efforts, this inverter features an integrated isolation transformer and integrated AC and DC disconnect in a compact single cabinet. The inverter can be ordered with a range of integrated DC subcombiner fusing options for maximum adaptability for the desired system operating scheme.
- Simple, innovative design: The AE inverter is a fully integrated solution with standard integrated data monitoring available and an optional premium data monitoring solution. Subcombiner monitoring and a revenue grade meter can be added for a complete performance monitoring solution.
- Adaptability: The AE inverter has a standard DC Maximum Power Point Tracking (MPPT) range from 295 VDC to 595 VDC.The minimum MPPT voltage is 265 VDC on LV models. The maximum input voltage is 600 VDC.

- Versatility: The AE inverter is designed for flexibility and can be used for a range of commercial applications, accommodating most PV system configurations.

PRODUCT FEATURES

The design of the PVP250kW and PVP260kW inverters include the following standard features.

- Equipped with redundant cooling system with variable speed fans and fault detection. The built-in backup capabilities enables the inverter to deliver full power at the maximum rated temperature even if one of the fans should fail. Fan status is reported as a warning shown on the display and through remote monitoring.
- Includes anti-islanding protection and monitoring functions to prevent the inverter from feeding power to the utility grid in the event of a utility outage.
- Utilize EMI input and output filtration to prevent electromagnetic interference.
- Field-selectable voltage and frequency trip points.
- Remote monitoring system using a standard Ethernet data reporting and communications interface PCB. With a high speed connection, this interface can provide PV system performance data in the following methods:
  - Subscribe to the standard monitoring service on the secure AE website. This recommended method allows the user to track the PV system and inverter information online. The basic monitoring service is available to all registered users.
  - Provide data to incentive-based performance monitoring and reporting programs for third parties.
- Inverter control through Modbus/TCP or Modbus/RTU for standard and optional features:
  - Power curtailment
  - Power factor control
  - Monitoring
  - Remote disable
- Inverter remote disable for remote control by opening an external switch or set of contacts.

MAJOR COMPONENTS AND FUNCTIONAL PARTS

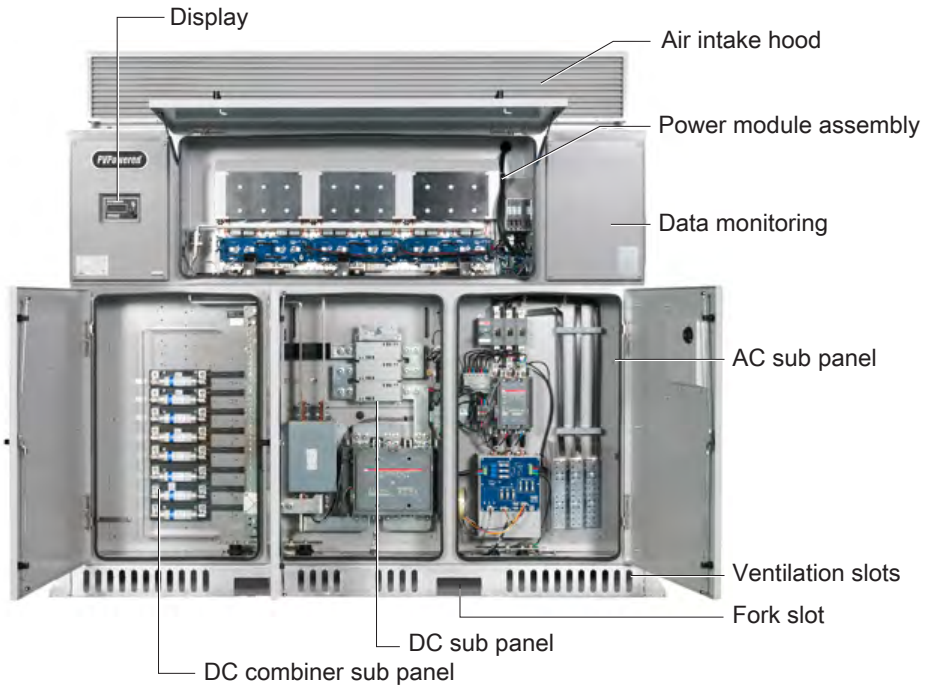


Figure 2-1. *Components of the PVP250kW and PVP260kW inverters*

The modular design of the inverter makes them easy to access and service. As shown in the preceding illustration the inverter is composed of two main sections:

- The upper compartments contains the power module assembly for the power conversion electronics including:
  - Power module assembly
  - Control printed circuit boards (PCB)
  - Power distribution PCB
  - Power supply
  - Active cooling system
  - Dedicated data monitoring in the right compartment
- The lower and magnetics compartments house the following:
  - DC combiner sub panel contains the optional fused subcombiner, optional subcombiner monitoring, and the positive, negative, and ground bars
  - DC sub panel with integrated DC ground fault detector interrupter (GFDI) PCB, surge protection, and DC disconnect
  - AC sub panel with AC output filtering, surge protection, and AC connection points

- Magnetics compartment contains the isolation transformer and inductors

Power Module Assembly

The inverter uses insulated gate bipolar transistors (IGBTs) for converting DC power into three-phase AC power. The inverter is protected by over-current, over-voltage, and over-temperature detection controls. If a protection system is activated, the power module will cease power conversion and send an interrupt signal to the digital signal processor (DSP).

Figure 2-2. *Power module assembly*

Card Cage Assembly

The card cage assembly in the following figure is designed to enable fast and easy service and also acts as an EMI shield to ensure signal integrity on the following PCBs:

- Communications PCB: Provides serial, internet, and Modbus communications.
- Power distribution PCB: Distributes the required logic level voltages for use throughout the inverter.
- Controller PCB: Controls sine wave generation, logic functions, and protection activities. All analog and digital inputs and outputs are routed to the control PCB.
- I/O PCB: Provides a central location for a range of input, output, and control circuits.

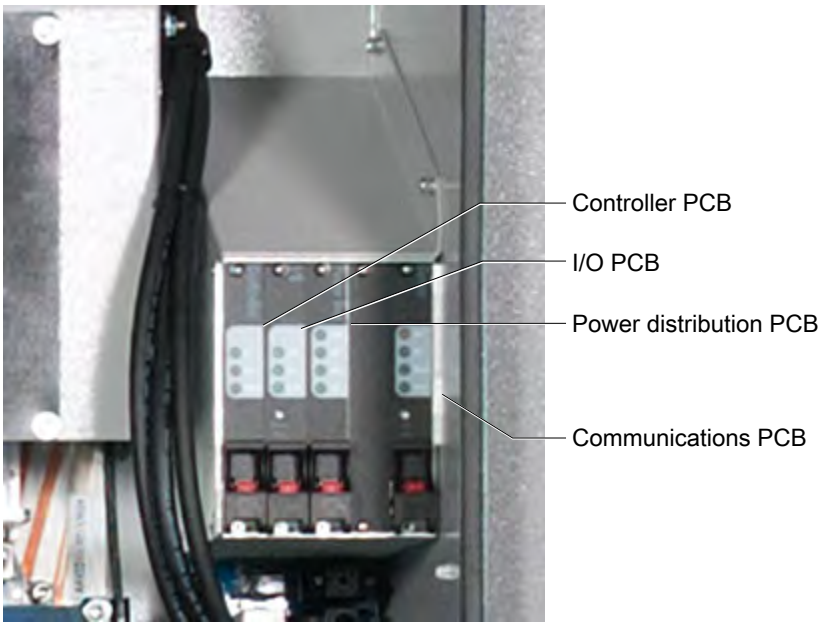


Figure 2-3. *Card cage assembly*

Data Monitoring Card Cage

COMMUNICATIONS INTERFACE PCB

The communications interface PCB is located in the data monitoring section in the front upper right of the inverter. The primary purpose of the communications interface PCB is to provide a means to communicate with the inverter through either Modbus RTU or Modbus TCP/IP. These connections can be used for third party monitoring or for web-based inverter monitoring through AE's mypvpower.com (which uses a proprietary Ethernet protocol). The communications interface PCB includes:

- RJ45 Ethernet port for network connectivity
- Remote disable terminal blocks, which allow the inverter to be disabled through external methods such as an e-stop, generator interlock, or fire alarm panel
- Binary Modbus device addressing switch
- Modbus slave port terminal blocks for daisy-chain connection to an RS-485 network
- Serial port is available for AE Solar Energy Technical Support use only

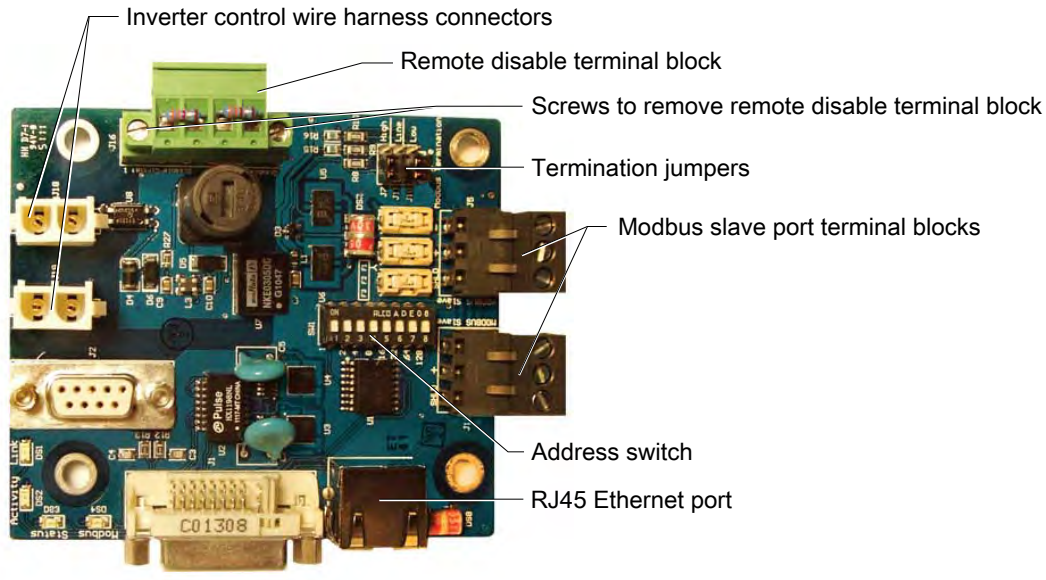

Inverter control wire harness connectors
Remote disable terminal block
Screws to remove remote disable terminal block
Termination jumpers
Modbus slave port terminal blocks
Address switch
RJ45 Ethernet port

Figure 2-4. Communications interface PCB

Operator Interface Controls

The vacuum fluorescent display (VFD) located on the front upper left of the inverter cabinet includes both a digital display screen and two buttons. The display screen shows the inverter's state, scrolling continuously through the screens. The **Scroll/ Pause** button controls the display screen and the **ON/OFF** switch enables or disables the inverter.

Active Cooling System

The inverters come with fans which activate as needed to keep the internal components within preset temperature limits. These fans are located under the air intake hood of the inverter.

DC Combiner Sub Panel

The DC combiner sub panel compartment is where the inverter connections to the PV source circuits are completed, including the positive, negative, and ground bus bars.

Optional fused subcombiner and subcombiner monitoring are also located in the DC combiner sub panel if selected.

DC conductors from the array can enter through the side or bottom gland plates.

DC Sub Panel

This sub panel houses the DC disconnect, DC distribution PCB, fuses, and surge protection.

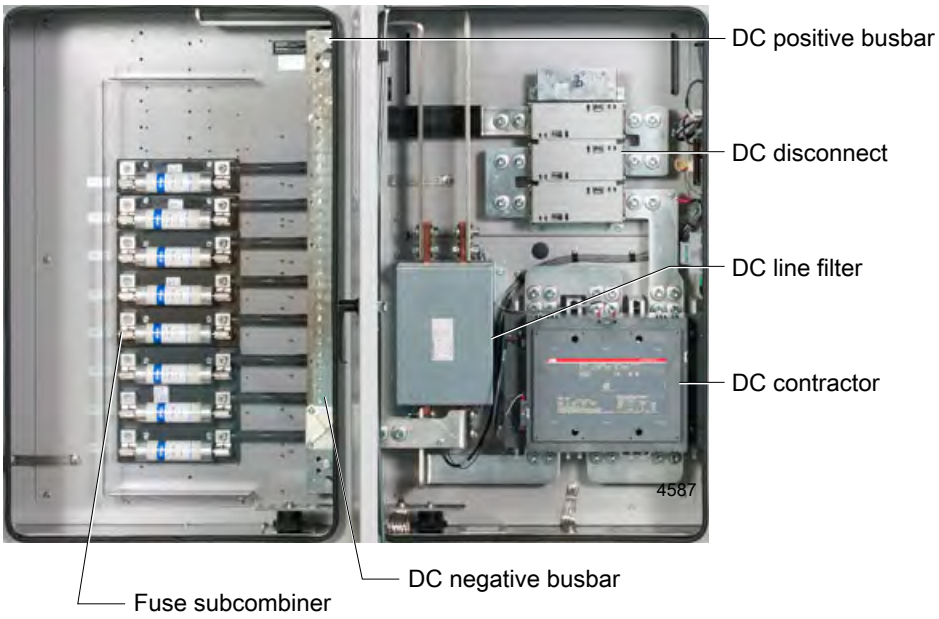


Figure 2-5. DC sub panel and DC combiner sub panel

DC Distribution PCB

The DC distribution PCB is located on the DC sub panel. This PCB includes the DC voltage sensing and DC soft start circuit. The DC distribution PCB also houses the ground fault detector interrupter (GFDI) circuit. The purpose of the GFDI is to detect a ground fault (unintended current flow from the solar panels to earth ground) and in the event of a ground fault, stop AC power production.

Figure 2-6. DC distribution PCB

WARNING:

Risk of electrical shock. The GFDI functions using a fuse to connect or bond the solar array negative (or the solar array positive, if using a positively grounded panel array) to earth ground.

AVERTISSEMENT:

Risque d'électrocution. Les fonctions GFDI utilisent un fusible pour connecter ou lier le négatif du panneau solaire (ou le positif du panneau solaire, si l'on utilise un panneau mis à la masse du positif) à la prise de terre.

If the ground fault current exceeds 5 A between the grounded array terminal and the earth ground, the GFDI fuse will open and disconnect the solar panels from their ground reference, interrupting the ground fault. In this situation, the inverter will cease operation, display a fault message, and the LED on the DC distribution PCB will illuminate red. If a GFDI current of 3-5 A exists, the inverter will indicate a ground fault warning.

AC Sub Panel

The AC landings, filtering, and sense fusing takes place in the AC sub panel. The AC sub panel also includes the load-break-rated AC contactor, AC disconnect, surge modules, and the soft-start circuit.

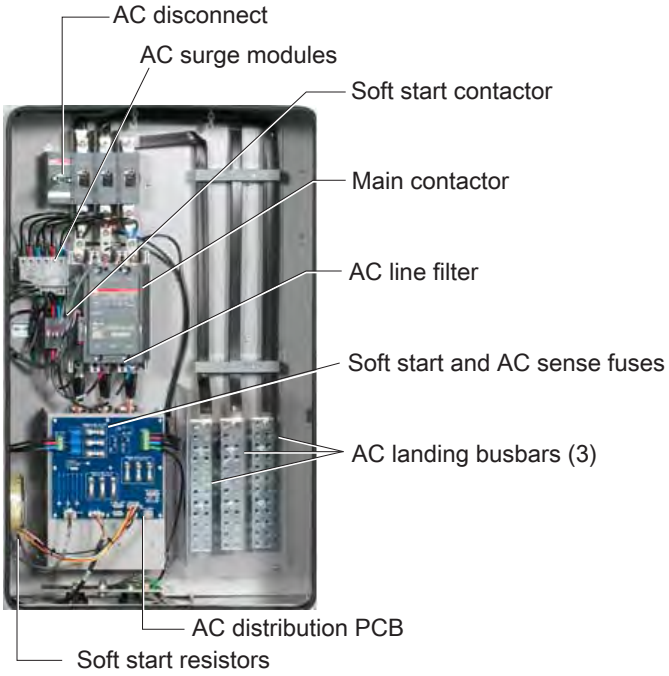


Figure 2-7. AC sub panel

The AC distribution PCB is located on the AC sub panel. The AC distribution PCB contains:

- Soft-start circuitry
- Fusing for the soft-start circuit
- Fusing for the AC sense circuit and 48 VDC power supply
- Fusing for the optional 24 VDC balance-of-system power supply

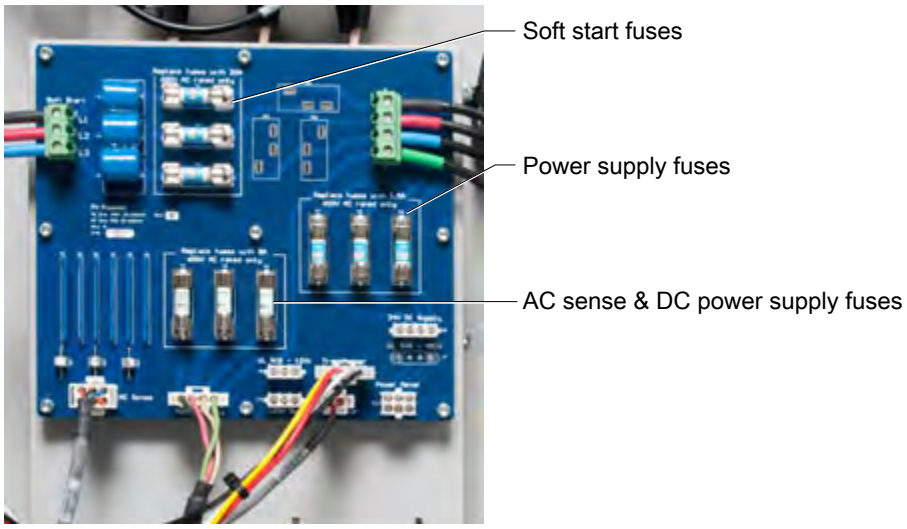


Figure 2-8. *AC distribution PCB*

Housekeeping Transformer

The housekeeping transformer, located in the bottom left of the AC sub panel, is a voltage conversion device that transforms 480 VAC to 120 VAC for use within the inverter. On 600 VAC models the transformer converts 600 VAC to 240 VAC.

Magnetics Compartment

The magnetics compartment contains the isolation transformer and the inductors.

- Isolation transformer: The inverter comes equipped with an integral isolation transformer. The isolation transformer is designed for class-leading inverter efficiency.
- Inductor: The inductor is used to filter the AC waveform generated by the power module, effectively reducing high frequency noise.

Planning

GENERAL REQUIREMENTS FOR PLANNING AND INSTALLATION

Planning for an installation of an AE inverter should only be performed by qualified engineers with a thorough understanding of the processes involved for a successful installation. Licensed and trained installers must comply with all local and national code requirements for the installation of electrical power systems with AC and DC voltages to 600 V.

The inverter must be anchored to a concrete mounting pad. The mounting pad must meet local seismic requirements. Refer to the mechanical drawings in this manual for optional seismic-rated concrete pad mounting requirements.

HANDLING THE INVERTER

WARNING:

Heavy equipment. PVP250kW/PVP260kW units weigh up to 2360 kg (5200 lb) with pallet and packaging. If the unit is lifted incorrectly, it may result in death. In addition, improper handling may result in serious damage to the unit and may also void the warranty. Keep all doors securely closed while moving the unit. Only use lifting equipment that is rated for the weight of the unit. Only use the specified lifting points.

AVERTISSEMENT:

Équipement lourd. Les unités PVP250kW/PVP260kW pèsent jusqu'à 2360 kg (5200 lb) avec palettes et emballage. Tout levage inadéquat de l'unité peut provoquer la mort. De plus, toute manipulation inadéquate peut provoquer des dommages graves à l'unité et pourrait aussi annuler la garantie. Garder toutes les portes bien fermées lors du déplacement de l'unité. Utiliser uniquement un équipement de levage d'une capacité nominale convenant au poids de cette unité. Utiliser uniquement les points de levage spécifiés.

The inverter can weigh up to 2360 kg (5200 lb) with the pallet and packaging. If the inverter is improperly handled, serious damage can occur and the warranty may be voided. Only use lifting equipment that is rated for the weight of the inverter. Only

use the specified lifting points. Leave the inverter on its shipping pallet with the protective plastic wrap in place until it is time to install.

☞ **Important**
Do not lift the inverter from the upper bolt points.

STORAGE

Prior to installation, the inverter should be stored in a dry, non-condensing environment to avoid potential rust and corrosion. Remove the transport bag when the inverter is ready for installation. If the hood scoop is not installed it needs to be installed immediately.

LOCATION AND CLEARANCES

Location

Select a suitable location to install the inverter. The inverter must be installed on a flat, solid surface such as a concrete pad.

Noise

The inverter is capable of emitting audible switching noise and should be located away from noise sensitive areas that are populated by people or animals.

Recommended Clearances

Working clearances must comply with your national and local electrical code.

Table 3-1. Inverter clearances

Location	Distance	Description
Front	914 mm (36″)	The front clearance is required to open and maintain the unit or as required by local code.
Rear	51 mm (2″)	The rear clearance is required behind the inverter to allow room for full opening of the air intake hood.

Table 3-1. Inverter clearances (Continued)

Location	Distance	Description
Sides	305 mm (12″) or 914 mm (36″)	The minimum side clearances are 305 mm (12″) on one side of the inverter and 914 mm (36″) on the other side to allow access to the external mounting flanges. The installer may select which side has clearance. The 914 mm (36″) will provide future access to the magnetics section for retorquing bolts and thermal scans of connections. However, the 914 mm (36″) on the side is not a NEC setback requirement. 305 mm (12″) on each side is an acceptable installation practice.
Top	457 mm (18″)	The top clearance is required above the air intake hood to maintain the filters and fans.

Clearances are shown in the figure below.

Figure 3-1. Inverter clearances

Only one side, right or left, is recommended to have the full 914 mm (36″) clearance while the remaining side must have 305 mm (12″). The above example demonstrates 305 mm (12″) on the left with 914 mm (36″) on the right side. This allows access to the magnetics section for retorquing bolts and thermal scan of connections. This is not a code setback requirement and 305 mm (12″) on each side is an acceptable installation practice.

CONDUIT AND CONDUCTORS

All the external conduit and conductors are to be supplied by the installer. All interconnect wiring and power conductors interfacing to the inverter must be in accordance with national and local electrical code. All conductors shall be rated for 90°C (minimum).

Large gauge wire must conform to the minimum bend radius specified by applicable national and local codes.

External cable interfaces are through bottom or side gland plates. The gland plates must be in place for operation of the inverter. Gland plate locations are included on the mechanical drawings in the appendix.

ENVIRONMENTAL REQUIREMENTS

The unit may be installed either indoors or outdoors. If the installation of the inverter is outdoors, all interconnect conduit and fittings must be rated NEMA 4 (same as the inverter rating) as required by the NEC. For high temperature locations a shade structure should be placed over the unit in order to reduce thermal stress and extend the product's life.

Inverter power output will be de-rated for ambient temperatures in excess of 50°C/ 122°F.

Do not cover the ventilation slots around the base of the inverter, which are essential for proper air flow and cooling. This does not apply to AE designed PowerVault enclosed skid solutions.

Table 3-2. Cooling and heat rejection rate requirements

Requirement	Rate	Description
Cooling air flow rate (maximum)	2,300 CFM	No external intake or exhaust air ports are required in the building if air flow volume needs are met.
Heat rejection rate (maximum)	41,000 BTU/hr.	n/a

GROUNDING AND NEUTRAL REQUIREMENTS

PV Array Frame Grounding

DANGER:

Do not connect the PV negative or positive conductors to the ground bus bars provided. The PV array is grounded through the integral GFDI. Connecting the PV array positive or negative conductors to ground at any other point in the system would defeat the ground fault protection circuit.

DANGER:

Ne pas brancher les conducteurs négatifs ou positifs du PV aux barres omnibus mises à la terre fournies. Le panneau photovoltaïque est mis à la terre au moyen du GFDI. La connexion des conducteurs positifs ou négatifs du panneau photovoltaïque à la terre à tout autre point du système pourrait déjouer le circuit de protection contre les défauts de terre.

CAUTION:

The inverter may be factory configured for either positive or negative ground. It may NOT be field configured to a different grounding once it is shipped from the factory. To identify if your inverter is configured for positive or negative ground read the label next to the DC landing bus bar. Verify that the grounding configuration matches your installation grounding plan. If you need to reconfigure the ground, contact Advanced Energy for assistance. DO NOT ground either DC lead at the time of installation. This will defeat the integral GFDI circuit.

ATTENTION:

L'inverseur peut être configuré à l'usine pour une mise à la terre positive ou négative. Il ne peut PAS être configuré sur le terrain à une mise à la terre différente une fois qu'il a été expédié de l'usine. Pour savoir si votre inverseur est configuré pour une mise à la terre positive ou négative, lire l'étiquette près de la barre omnibus CC. Vérifier que la configuration de mise à la terre correspond à votre plan de mise à la terre d'installation. Si on a besoin de reconfigurer la mise à la terre, contacter Advanced Energy pour de l'aide. NE PAS mettre à la terre le fil CC au moment de l'installation. Cela déjouerait le circuit GFDI.

The inverter incorporates an integral GFDI device. The PV array safety ground (frame ground) may be attached to the provided grounding bus bar. The grounding

bus bar is located below the DC subpanel compartment in the front left of the inverter cabinet. The PV array is grounded internally by means of the GFDI.

The inverter is shipped preconfigured with positive or negative PV array grounding based on the preference specified when the order is placed.

System Neutral

The inverter has been certified to national standards for installation without a neutral conductor. Do not connect a neutral conductor from the AC service panel to the inverter.

WARNING:

The AC output/neutral must not be bonded to ground within the equipment.

AVERTISSEMENT:

La sortie et le neutre CA ne doivent pas être branchés à la masse à l'intérieur du dispositif.

UTILITY GRID INTERCONNECTION

Utility Connection Requirements

Review all applicable national or local codes for specific requirements for the size of the electrical service and the amount of current that is allowed to be fed into the panel by the inverter.

Contacting Your Local Utility

Contact your electrical utility before connecting the inverter to ensure there are no local restrictions or special requirements. Your local utility company may require specific inspections, equipment, or other procedures not covered in this document.

Voltage Output

This inverter is designed to be connected to a three phase, grounded, wye transformer. The AC output voltage is available on the inverter name plate for the output voltage wye configuration. Do not change the output voltage of the inverter. AC and DC power requirements are included in the specifications.

Related Links

- "Specifications" on page 9-1

INVERTER MONITORING

The inverter is equipped with a data monitoring module that can be used to monitor the inverter through one of the following interfaces:

- Basic performance data can be accessed using a free web-based monitoring service provided by AE.
- Locally through a third party monitoring system using Modbus/TCP or Modbus/RTU.

Related Links

- "Data Monitoring and Controls" on page 6-1

CALCULATING DC INPUT VOLTAGE

To Calculate Maximum Open Circuit Voltage

- Calculate the maximum open circuit (no load) voltage for each series module connection. Refer to the Advanced Energy Solar Energy web site and select the **String Calculator** to calculate the input from the PV array.

  Contact AE Solar Energy Technical Support if you require assistance calculating the maximum DC input voltage for your array at your specific location.

☞ **Important**
Each DC input connection must be wired to deliver the same input voltage.

☞ **Important**
For all temperature conditions, the open circuit voltage for each series connection must be less than or equal to 600 VDC.

DC SUBCOMBINER OPTIONS

The inverter comes with standard positive and negative bus bars for landing DC inputs from the PV array.

Optional 8, 16, and 20 circuit internal subcombiner boxes are available as shown in the figure below. In addition, the 8 and 16 circuit subcombiners can be ordered with monitoring on each input circuit.

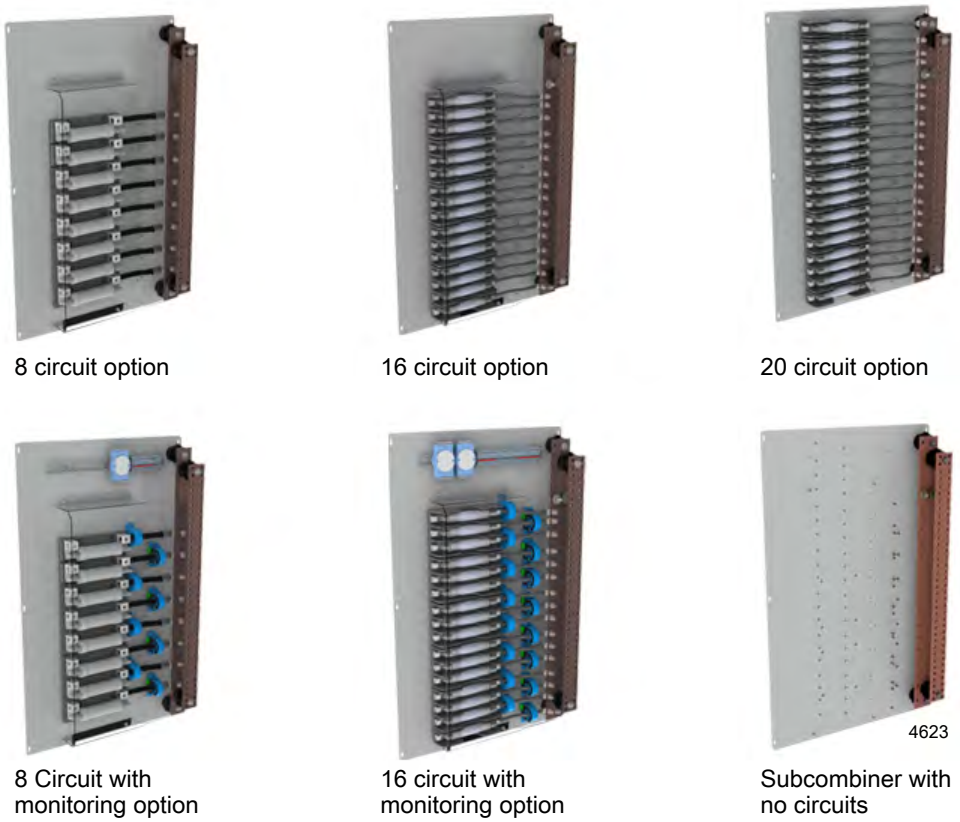


Figure 3-2. *DC subcombiner options*

Fuse Protection for DC Input

The installer is responsible for providing proper fuse protection for the DC input circuit if the fused subcombiner option is not included in the order.

Installing

HANDLING AND UNPACKING

This section describes the required safe handling and unpacking procedures for the AE inverter. Always follow the recommendations in this section to prevent accidental damage or injury.

Packaging Contents

The following items are included with the inverter when it is packaged for shipping:

- Manual
- Warranty card
- Final test report
- Keys for door handles

Handling and Unpacking the Inverter

TOOLS REQUIRED

- Two 3/4″ wrenches or one wrench and one 3/4″ socket wrench
- Lifting device such as a forklift or pallet jack
- Utility knife

The inverter can be moved using a forklift or pallet jack that is rated to handle a minimum of 2360 kg (5200 lb).

TO UNLOAD AND UNPACK THE INVERTER

WARNING:

Heavy equipment. PVP250kW/PVP260kW units weigh up to 2360 kg (5200 lb) with pallet and packaging. If the unit is lifted incorrectly, it may result in death. In addition, improper handling may result in serious damage to the unit and may also void the warranty. Keep all doors securely closed while moving the unit. Only use lifting equipment that is rated for the weight of the unit. Only use the specified lifting points.

AVERTISSEMENT:

Équipement lourd. Les unités PVP250kW/PVP260kW pèsent jusqu'à 2360 kg (5200 lb) avec palettes et emballage. Tout levage inadéquat de l'unité peut provoquer la mort. De plus, toute manipulation inadéquate peut provoquer des dommages graves à l'unité et pourrait aussi annuler la garantie. Garder toutes les portes bien fermées lors du déplacement de l'unité. Utiliser uniquement un équipement de levage d'une capacité nominale convenant au poids de cette unité. Utiliser uniquement les points de levage spécifiés.

1. Lift and move the inverter using the shipping pallet.

   Do not penetrate the packaging or use the inverter base for unloading.

2. Remove the protective plastic wrap encasing the inverter.

   If no damage is apparent, proceed with the next step. If you do see signs of shipping damage, contact AE Solar Energy Technical Support and the carrier immediately.

3. Using a 3/4″ wrench, loosen the bolts and nuts securing the inverter to the pallet.

PRE-INSTALLATION INSPECTION

Before placing and installing the inverter, the inverter should be inspected to identify possible external and internal shipping damage. If a problem is identified during any of these inspection steps contact AE Solar Energy Technical Support.

Pre-Installation Inspection Tools

The following tools are needed to perform the pre-installation inspection of the inverter:

- Large flat blade (common) screwdriver
- Access door entry key
- Hex wrench

Step 1: External Inspection

1. Inspect the shipping materials and the inverter for any cosmetic or structural damage. Specifically look for any structural damage or crushing of the base or doors.
2. Confirm all doors open freely and easily.

The front doors on the main compartments of the inverter have a rotating hand latch with integral key lock to secure the main compartment doors.

Step 2: Inspection of the Magnetics

1. Using a hex wrench remove the large cover plates on the sides of the inverter to access the magnetics.
2. Inspect the following connections:
   a. The three large bus bars at the top of the power drive into the inductors
   b. Three from the inductors to the transformer
   c. Three from the transformer to the back of the AC bulkhead

   For each connection check the integrity of the bus bar connections and terminals.

Figure 4-1. *Bus bar terminal and connection*

3. Check the screens at the bottom of the compartment for damage or debris.

Figure 4-2. *Screen check*

4. Ensure the air deflector is held firmly in place.

Figure 4-3. Air deflector check

5. Replace the cover plates. Make sure the gaskets are not damaged during replacement of the plates. Do not overtighten the screws.

Step 3: AC and DC Sub Panel Compartments

1. Check the integrity of the bus bar connections and terminals for each bus bar landing in the AC and DC compartments.

Figure 4-4. Bus bar connection inspection

2. Ensure the cable connections are plugged in and fully seated.

Figure 4-5. Inspection of cable connections

3. Inspect and pull test all cable screw terminal connections.

Figure 4-6. Pull test of cable screw terminal connection

4. Inspect the screens at the bottom of the compartment for damage or debris.

Figure 4-7. Screen inspection

If any loose wires are found during the inspections, and the correct location of the connection is unknown, contact AE Solar Energy Technical Support.

Step 4: Upper Electronics Compartment

- Check the integrity of the bus bars and their connections in the upper electronics compartments.

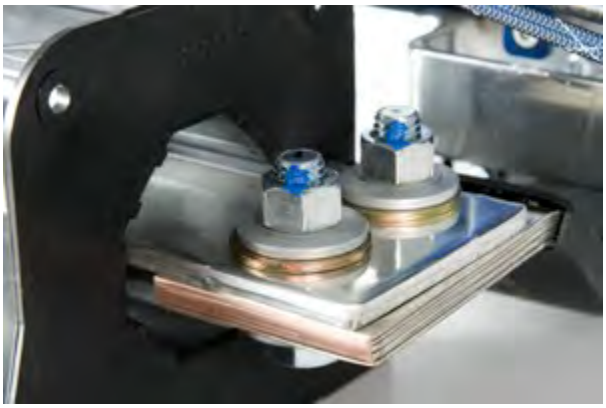


Figure 4-8. Check the bus bar connections

Step 5: Upper Active Cooling Compartment

1. Ensure the fans spin freely.

Figure 4-9. *Fan inspection*

2. Ensure all air filters are fully seated.

Figure 4-10. Air filter check

This completes the pre-installation inspections.

LIFTING AND MOUNTING THE INVERTER

The inverter base is designed to allow a properly rated forklift to lift it from the front or back using the fork slots.

☞ **Important**
Before installing the inverter, make sure the pre-installation inspection steps have been completed and no issues have been identified.

Mounting Requirements

When mounting the inverter, consider the following requirements:

- Mount the unit on a flat surface in an upright position.
- The mounting surface must comply with all national and local standards for weight, seismic, and wind sheer requirements.
- The mounting surface must be prepared according to the site specific structural drawing.

Required Tools

- Lifting device such as forklift or a pallet jack or an alternate method of lifting and positioning the inverter may be used. Lifting devices must be rated for 2360 kg (5200 lb). Proper lifting methods may include:
  - Using a crane with a strap rated for the weight of the inverter
  - Using lifting beams, spreader bars, or similar equipment rated for the weight of the inverter

To Lift and Mount the Unit

WARNING:

Do not attempt to lift the full weight of the unit from the left or right sides only. Attempting to lift from just the left or right sides only will result in an unstable and unsafe condition.

AVERTISSEMENT:

Ne pas tenter de soulever l'unité uniquement à partir du côté gauche ou droit. Toute tentative de soulever l'unité par le côté gauche ou droit pourrait occasionner une situation d'instabilité dangereuse.

CAUTION:

Care MUST be taken to protect the inverter from compressive stresses or forces which may dent or deform the cabinet or cause damage to the inverter. Damage caused by improper handling may void the warranty. Safe handling, operating, and installation practices are the responsibility of the installer.

ATTENTION:

Redoubler de vigilance pour protéger l'inverseur des contraintes ou forces en compression qui peuvent endommager ou déformer l'armoire ou endommager l'inverseur. Les dommages causés par la manipulation inadéquate peuvent annuler la garantie. Les pratiques sécuritaires de manipulation, de fonctionnement et d'installation incombent à l'installateur.

Important

Damage caused by improper handling can void the warranty. Safe operating, handling, and installation practices are the responsibility of the installer.

1. Prepare the mounting surface according to the site specific structural drawing.
2. Lift the inverter off the pallet using the forklift slots on the front or back. The left and right fork slots are not designed for lifting the inverter.

The front and back of the inverter base each have two fork slots that are 109 mm (7.5") wide and 673 (26.5") apart on center.

☞ **Important**
The center of gravity is toward the back, lower third of the inverter and centered side to side. Refer to the mechanical drawings to view the center of gravity location.

3. Position the inverter in the selected location.

   Alternate methods of lifting and positioning the inverter may be used. Proper methods may include the use of a crane with a strap rated for the weight of the inverter; however, care MUST be taken to protect the inverter from compressive stresses or forces which may dent or deform the cabinet or cause damage to the inverter. Use of lifting beams, spreader bars, or similar equipment rated for the weight of the inverter can be employed for this purpose.

4. Secure the inverter to the mounting surface by setting the anchoring hardware through each of the six holes in the external mounting flange on the base of the unit.

   Refer to the mechanical drawings in the Appendix to review the anchoring locations.

CONDUIT ENTRY POINTS

The inverter is shipped from the factory with side and bottom gland plates that allow for conduit entry.

☞ **Important**
All penetrations in the inverter cabinet must be through the specified gland plates which are for the sole purpose of providing a safe and convenient way to route wiring in to and out of the inverter. Penetrating the inverter housing in any other location besides the gland plates voids the warranty.

☞ **Important**
Do not block the cabinet's side access with conduit.

☞ **Important**
Do not attach conduit support structure to the cabinet.

Using Gland Plates for Cable Conduit Entry and Exit

All power cabling and communications wiring must enter and exit via the inverter cabinet’s gland plates. There are gland plates on the AC and DC sides of the inverter for bottom and side entry. In addition, there is a gland plate on the upper right side for data monitoring wiring. Each gland plate location is selected to ensure safe installation, proper airflow and prevention of dust, debris, moisture, insect, and

animal incursion. Do not penetrate the cabinet at any other location. All gland plates need to be installed for proper operation of the inverter.

TOOLS REQUIRED

- 5/32″ hex wrench
- NEMA 4 conduit hubs
- Knockout punch

TO USE THE GLAND PLATES

☞ **Important**

All penetrations in the inverter cabinet must be through the gland plates which are provided for the sole purpose of a safe and convenient way to route wiring in to and out of the inverter. Penetrating the inverter cabinet in any other location besides the gland plates voids the warranty.

☞ **Important**

Remove all metal shavings and wire scraps from the inverter prior to replacing the gland plates.

1. Select the size(s) and location(s) of the hole(s) that need to be punched.

Figure 4-11. DC bottom entry gland plates

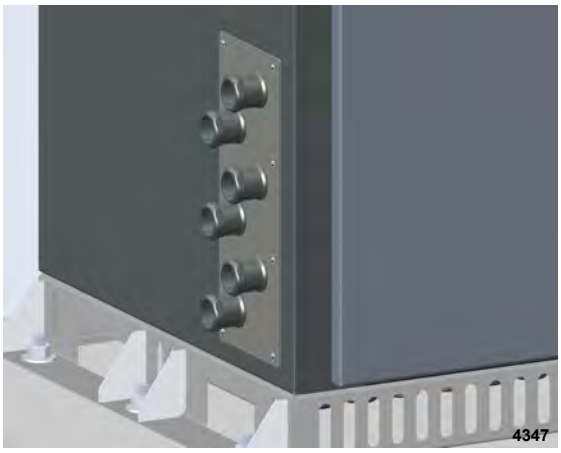


Figure 4-12. DC side entry gland plates

2. Remove the gland plate while taking care not to damage the weatherproof gasket material on the back side of the plate.
3. Punch holes as needed in the gland plate.
4. Attach watertight NEMA 4 conduit hubs in each hole.

   The inverter is a NEMA 4 enclosure. Use only rain-tight or wet-location conduit hubs and install these hubs as shown in the following figure.

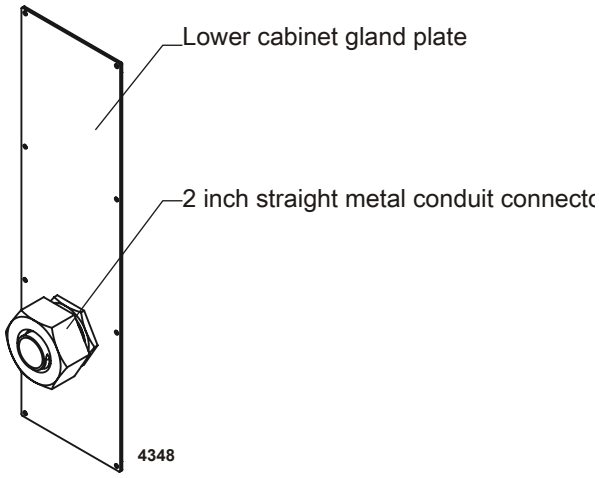


Figure 4-13. Installation of conduit hub

CAUTION:

For outdoor installations make liquid-tight connections to the unit.

ATTENTION:

Pour les installations extérieures, effectuer des connexions étanches à l'unité.

5. Replace the gland plate taking care to evenly seat the gasket material against the cabinet.

6. Tighten until the gland plate is snug. Do not overtighten.

ELECTRICAL CONNECTIONS

DANGER:

Electrical connections must comply with national and local standards. Voltage drop and other considerations may dictate that larger wire sizes be used.

DANGER:

Les connexions électriques doivent être conformes aux normes nationales et locales. Des chutes de tension et autres facteurs peuvent imposer l'usage de fils de plus gros calibre.

DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

DANGER:

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.

After the inverter is properly secured to the mounting pad and the conduit hubs have been installed the electrical connections can be completed. Terminal connections for the inverter are located inside the inverter. When facing the inverter the connections are located in the following areas:

- DC terminals are on the left side
- AC terminals are on the right side

Both AC and DC bus bars accept standard terminal lug-crimped wires mounted to the bus bar fittings with standard grade 8, 3/8″ mounting hardware.

For the optional fused subcombiners, the conductor is inserted directly into the fuse holder assembly. The following table lists the accepted wire sizing for each subcombiner lug option.

Table 4-1. Subcombiner wire sizing and torque values

Fuse Block Maximum Amperage	Maximum Wire Size	Required Torque	Terminal Temp. Rating
200	Al/Cu 350kcmil-#6	42 Nm (31 ft-lb)	75°C
100	Al/Cu #2/0-6	14 Nm (10 ft-lb)	75°C
Direct to bus bar	No wire size limit. Must use grade 8 3/8″ hardware.	54 Nm (40 ft-lb)	90°C

AC Wiring

☞ **Important**
The inverter is certified for installation without a neutral conductor. Do NOT pull a neutral conductor from the AC service panel to the inverter.

The inverter is designed for use with the following three-phase power grids.

- 480 VAC
- 600 VAC

☞ **Important**
The inverter must be connected to a grounded wye configuration.

The voltage output is not selectable on AE inverters. Do not attempt to change the AC output voltage once it is set at the factory.

Use the applicable national and local electrical code to select the appropriate AC wire sizing for your application. Correct wire sizing requires, at a minimum, considerations for ampacity, temperature, and conduit. In addition, wire should be sized to minimize voltage drop. Install the inverter on a dedicated branch circuit with a recommended circuit breaker rating as specified in the following table.

Table 4-2. Branch breaker size recommendations

Model	208 VAC	480 VAC	600 VAC
PVP250kW	N/A	400 A	350 A
PVP260kW	N/A	400 A	N/A
PVP260kW-LV	N/A	400 A	N/A

The inverter does not have internal AC fusing so it is important to size the branch circuit protection appropriately.

When an inverter is installed on an electrical panel the AC operating voltage range of the inverter should be considered. Voltages outside this range will cause the inverter

to fault. See the specifications section of this manual for AC operating voltage ranges.

Table 4-3. Operational voltage ranges per electrical panel

Electrical Panel	Operational Voltage Range
480 VAC	422 VAC – 528 VAC
600 VAC	528 VAC – 660 VAC

Related Links

• "Electrical Specifications" on page 9-1

CONNECTING TO THE ELECTRICAL GRID

The inverter is connected to the electrical grid using four wires:

- Phase A voltage
- Phase B voltage
- Phase C voltage
- Ground

☞ **Important**
Do NOT connect a neutral wire to the wye point of the isolation transformer.

The four AC termination bus bars for phases A, B, C, and ground are located in the lower right of the AC panel. The phase bus bars are vertically mounted and the ground bus bar is horizontally mounted at the bottom of the cabinet. Each bus bar has seven rows of two 3/8″ diameter holes, spaced 1″ apart vertically.

The AC connections must be made through conduit installed in the bottom or side entry gland plates.

Tools Required

- 5/32″ Allen wrenches (Allen wrench adaptor for a socket wrench recommended)
- 7/16″ open-end wrench or socket wrench and a 6″ extender
- Torque wrench

To Connect the AC Wiring

⚠ **WARNING:**
Follow the order listed in this section to wire the inverter. Failure to do so may result in hazardous voltages or disconnection of contacts.

AVERTISSEMENT:

Pour câbler l'onduleur, suivez les ordres décrits dans cette section. Tout manquement au suivi scrupuleux des instructions est susceptible d'entrainer des tensions anormales ou le débranchement de contacts.

DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.

DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.

CAUTION:

To avoid an increase in AC voltage to unacceptable values while the inverter is connected, the grid impedance value at the connection point should be as low as possible. By keeping the grid impedance value low, the system will achieve higher efficiency.

ATTENTION:

Afin d'éviter des surtensions inacceptables de CA lorsque l'onduleur est branché, assurez-vous que la valeur de l'impédance aux points de connexion au réseau public est la plus basse possible. Une faible valeur d'impédance permet un fonctionnement plus efficace de l'appareil.

WARNING:

Do not connect a neutral wire to the WYE point of the isolation transformer. Doing so will cause the inverter to malfunction and will void the warranty.

AVERTISSEMENT:

Ne branchez pas de câble neutre au point WYE du transformateur d'isolation. Un tel branchement causerait un fonctionnement défectueux de l'onduleur et annulerait la garantie.

CAUTION:

To reduce the risk of fire, connect only to a branch circuit with overcurrent protection appropriately rated in accordance with your national and local electrical codes.

ATTENTION:

Pour réduire le risque d'incendie, brancher seulement à un circuit de dérivation avec une protection de surintensité d'une capacité nominale conforme aux codes d'électricité nationaux et locaux.

CAUTION:

The input and output circuits are isolated from the enclosure. System grounding, when required by national and local electrical code, is the responsibility of the installer.

ATTENTION:

Les circuits d'entrée et de sortie sont isolés de l'enceinte. La mise à la terre du système, lorsqu'elle est exigée par le code d'électricité national ou local, est la responsabilité de l'installateur.

WARNING:

The AC output/neutral must not be bonded to ground within the equipment.

AVERTISSEMENT:

La sortie et le neutre CA ne doivent pas être branchés à la masse à l'intérieur du dispositif.

1. Remove the protective plastic cover with a 7/16″ socket wrench.
2. Run the conduit from the main breaker panel to the desired gland plate on the inverter.
3. Insert a conduit fitting in the gland plate and fasten with a locking nut.
4. Feed the PHASE A, PHASE B, PHASE C, and GROUND wires through the conduit and into the right side conduit opening of the inverter.
5. Connect the wires to the appropriate AC landings as follows:
   a. GROUND wire to the marked **EARTH GROUND** landing inside the inverter.
   b. Phase A, B, and C to the AC landings inside the inverter.

☞ **Important**
The inverter auto phases and will auto detect phase rotation.

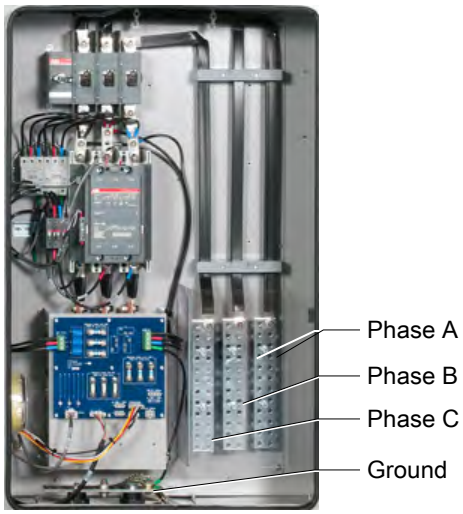


Figure 4-14. AC connections

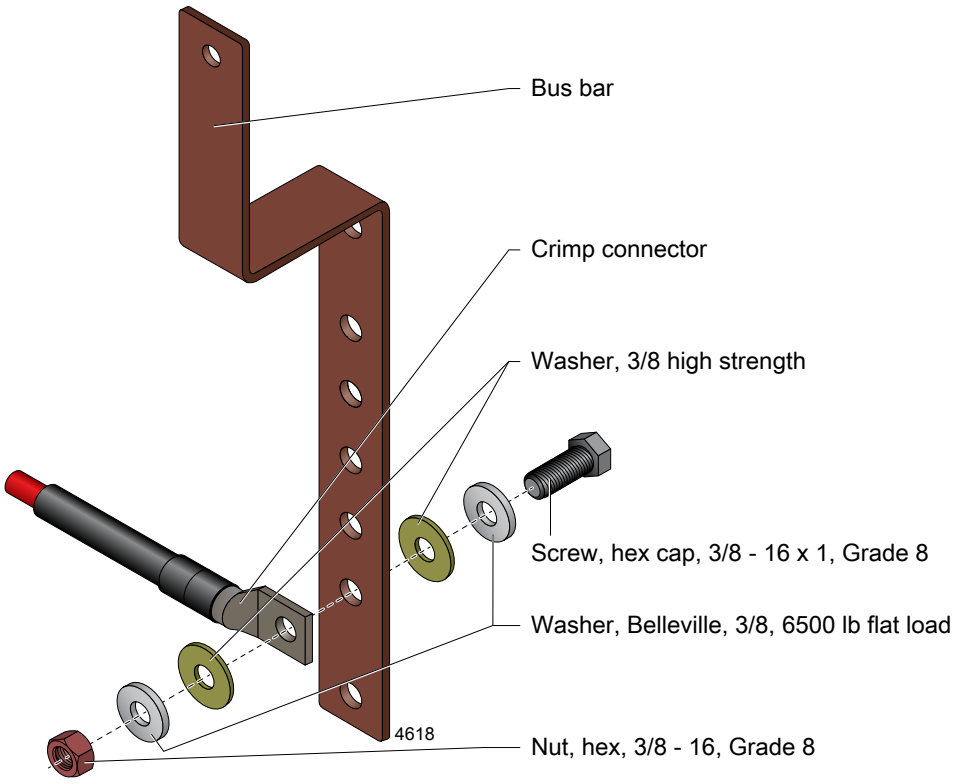

Bus bar
Crimp connector
Washer, 3/8 high strength
Screw, hex cap, 3/8 - 16 x 1, Grade 8
Washer, Belleville, 3/8, 6500 lb flat load
4618
Nut, hex, 3/8 - 16, Grade 8

Figure 4-15. Bus bar connections

Use grade 8, 3/8″ hardware to secure the lugs of the outgoing AC cables to the bus bars.

6. Ensure all connections are wired correctly and properly torqued. Tighten the AC terminal screws to 54 Nm (40 ft-lb).
7. Reinstall the protective plastic cover.

DC Wiring

The DC bus bars, positive, negative, and ground are located in the lower left compartment, the DC subcombiner panel. The positive and negative bars are vertically mounted and the ground bar is horizontally mounted at the bottom of the cabinet. The positive and negative bus bars have 32 rows of two 3/8″ diameter holes spaced 1″ apart vertically. The ground bar has 12 rows of two 3/8″ diameter holes spaced 1″ apart. See the following table for wire sizing limits for an inverter with an optional fused subcombiner.

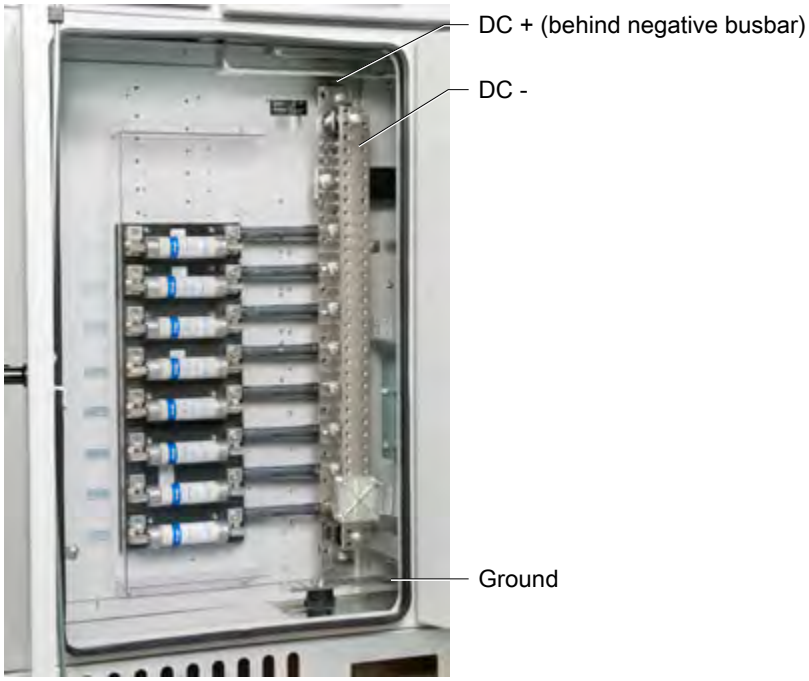


Figure 4-16. *DC connections*

CONNECTING TO THE PV ARRAYS

DANGER:

Before proceeding with the DC wiring, confirm that the PV array has been disconnected from the inverter using the external DC disconnect.

DANGER:

Avant d'effectuer les branchements CC, assurez-vous que les piles PV sont déconnectées de l'onduleur en utilisant le connecteur CC externe.

DANGER:

Make sure the PV array polarity and voltage between the positive and negative cables are correct before connecting the PV array cables to the DC terminal block.

DANGER:

Assurez-vous que la polarité et le voltage des câbles positifs et négatifs des piles PV sont corrects avant de brancher les câbles des piles PV aux bornes CC.

DANGER:

Risk of electrical shock. When exposed to light, PV arrays create electrical energy that could cause a hazardous condition.

DANGER:

Risque d'électrocution. Lorsqu'elles sont exposées à la lumière, les piles photovoltaïques génèrent un courant électrique susceptible de causer des conditions dangereuses.

Follow these steps to wire the DC inputs from the PV panels to the inverter. These instructions are for a negatively grounded array. For a positively grounded array, use the opposite terminals.

Tools Required

- 5/32″ Allen wrenches (Allen wrench adaptor for a socket wrench recommended)
- Open-end wrench or socket wrench
- Torque wrench
- Voltmeter

To Connect the DC Wiring

1. Disconnect power to the DC wiring by disconnecting the PV array outside the inverter before starting the DC wiring.
2. Clearly mark the array positive and negative leads.
3. Route the PV array leads through the conduit to the desired entry gland plate on the DC side of the inverter.
4. Connect the PV frame ground wire(s) to the ground lug on the point marked in the lower left side of the cabinet.
5. Connect positive DC cables(s) to the terminals located on the positive bus bar or fuse holder as applicable. Use grade 8, 3/8″ hardware to secure the lugs of

the incoming DC cables to the bus bar. The DC landing torque specification is 54 Nm (40 ft-lb).

6. Connect negative DC lead(s) directly to the terminals located on the negative DC bus bar as shown in the following figure. Use grade 8, 3/8″ hardware to secure the lugs of the incoming DC cables to the bus bar. The DC landing torque specification is 54 Nm (40 ft-lb).

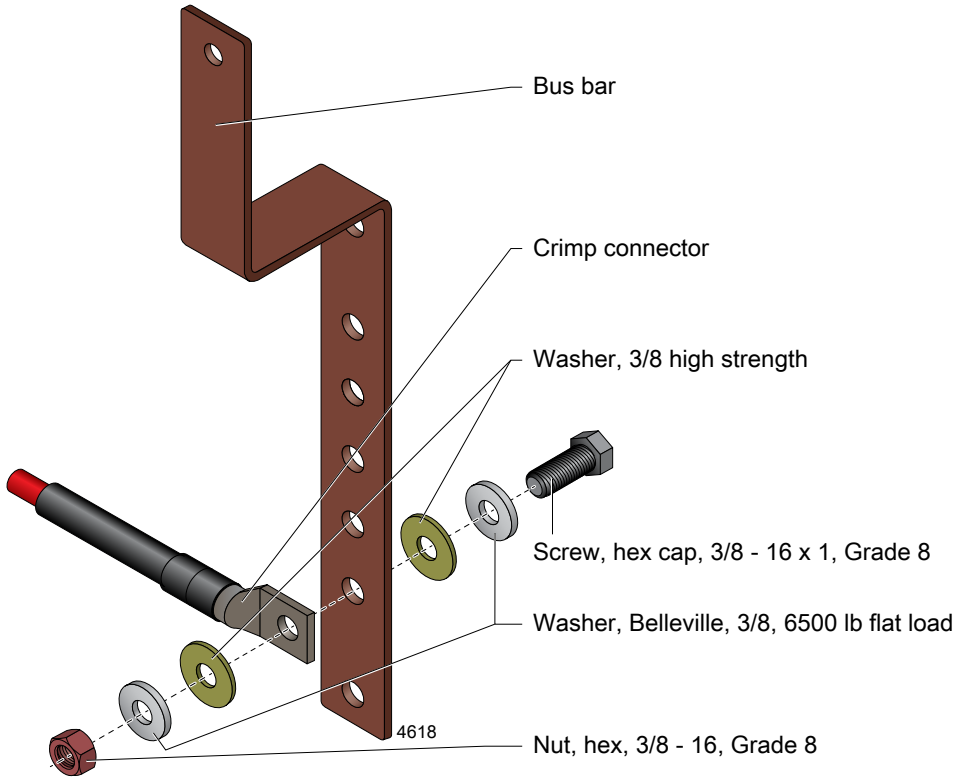

Bus bar
Crimp connector
Washer, 3/8 high strength
Screw, hex cap, 3/8 - 16 x 1, Grade 8
Washer, Belleville, 3/8, 6500 lb flat load
4618
Nut, hex, 3/8 - 16, Grade 8

Figure 4-17. *DC inverter connections*

7. Energize the DC cables.

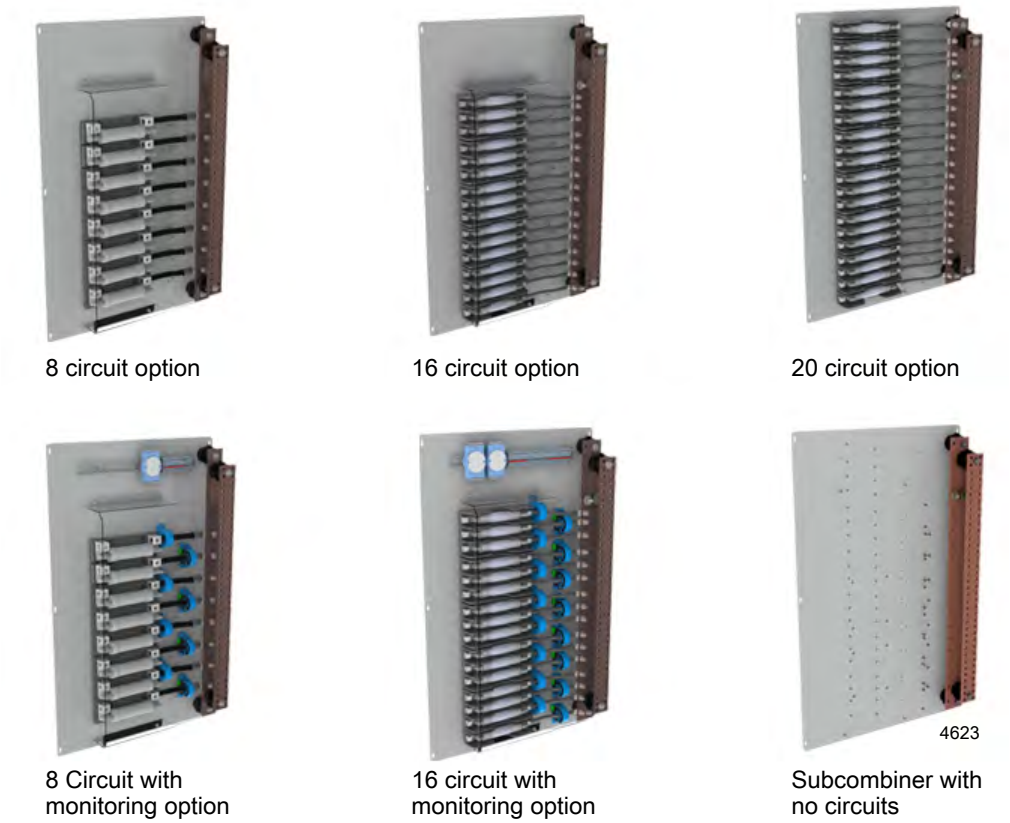


Figure 4-18. DC subcombiner configurations

8. Using a voltmeter, check the PV array positive leads and confirm the voltage is positive when referenced to the negative leads. The reading should not exceed your calculated series Voc or the 600 VDC maximum inverter input specification.
9. De-energize the DC cables.

Using the Integrated Remote Disable Input

There are two remote disable inputs available to the installer in the inverter. The inputs are located on the communications interface PCB which is located in the data monitoring compartment.

The remote disable inputs consist of two pairs of screw terminals to which a user can connect separate remote switches or contacts. Using the remote disable input allows the inverter to be shut down remotely by opening a switch or set of contacts. This feature would typically be used in conjunction with a fire alarm panel or a generator output signal. The contacts need to be normally closed for the inverter to operate. The customer will need to provide a 5 V, 5 mA tolerant relay, switch, or set of contacts.

☞ **Important**
Jumpers are installed across each of the terminal pairs to allow normal operation. Do not remove either of the jumpers unless you intend to use this feature.

☞ **Important**
Closing the remote disable contact with the inverter ON/OFF switch in the **ON** position will re-start the inverter.

MAKING THE REMOTE DISABLE CONNECTION

Parts or Tools Required

You need the following parts and/or tools to make the remote disable connection:

- Control wire, 22 AWG through 14 AWG
- Wire stripper
- Small screwdriver

☞ **Important**
Thin stranded wire is recommended.

The Remote Disable and Other On-Site Power Sources

The following information describes how to make the remote disable connection on the PVP250kW/PVP260kW inverter. The remote disable circuit requires a normally-closed contact capable of switching a 5 V, 5 mA signal. One or two remote disable connections can be made to the unit.

☞ **Important**
The PVP250kW/PVP260kW inverter cannot operate with this remote disable open. If the remote disable feature is not used, the remote disable terminal block jumpers must be left in place for the inverter to operate.

You are required to establish this external remote disable connection if an additional power source exists at your installation site that could be damaged if the PV system continues to run when the power source turns on. For example, if you have an on-site generator that supplies power when an electrical outage occurs, you should make the remote disable connection from the inverter to the on-site generator to ensure the PV system shuts downs when the generator turns on.

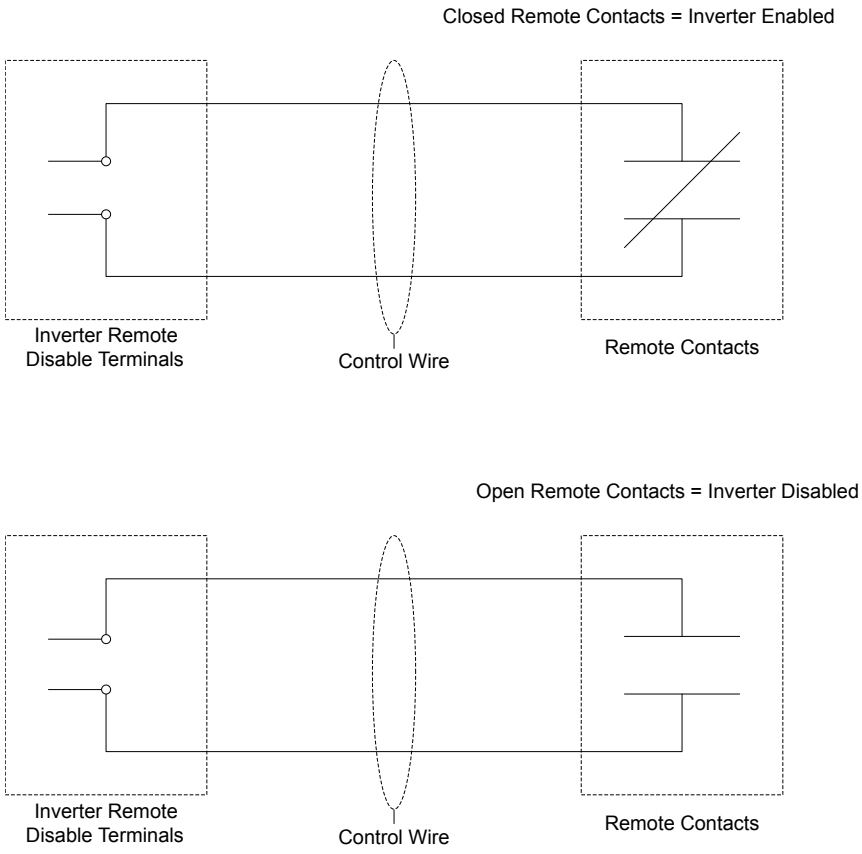


Figure 4-19. Remote disable wiring diagram

To Make the Remote Disable Connection

DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.

DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.

Important

This procedure is written for a single remote disable connection. If two remote disables are used, follow the same steps for each remote disable connection.

1. Disconnect the power to the inverter before starting the installation.
2. Remove the data monitoring gland plate on the upper right side of the inverter.

The data monitoring gland plate is a small, flat piece of metal covering the side entry port to the inverter's data monitoring compartment.

3. Drill or punch a hole in the desired location to allow access for the remote disable control wires.
4. Install a water-tight conduit hub connection.
5. Replace the gland plate.
6. Route the remote disable control wires from the remote device.
7. Locate the remote disable terminal block located on the communications interface PCB in the monitoring compartment.
8. If desired remove the terminal block by loosening the two mounting screws.
9. Locate and remove one jumper from the remote disable terminal block shown in the following illustration.

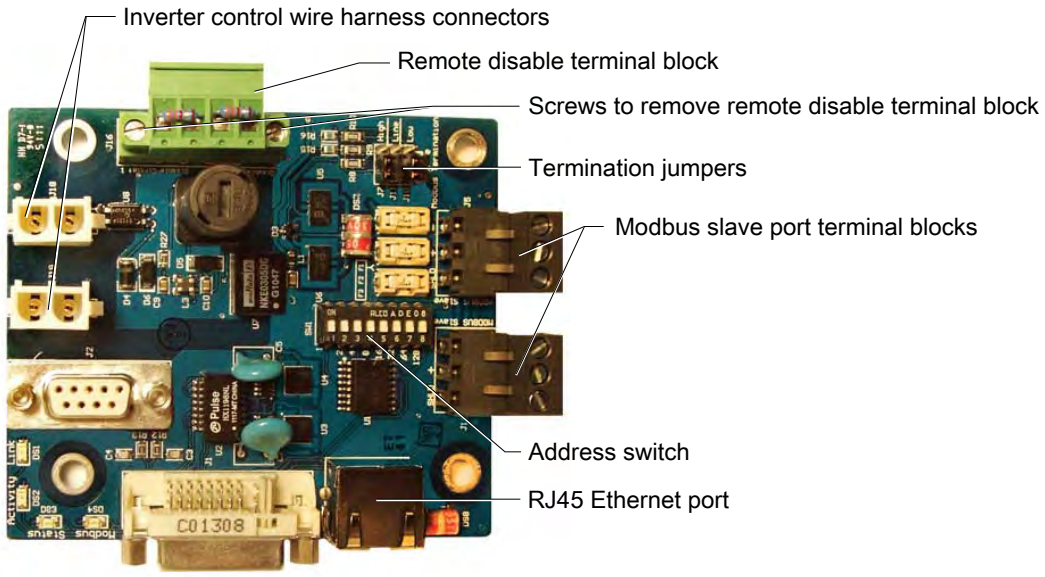

Inverter control wire harness connectors
Remote disable terminal block
Screws to remove remote disable terminal block
Termination jumpers
Modbus slave port terminal blocks
Address switch
RJ45 Ethernet port

Figure 4-20. Communications interface PCB

10. Strip approximately 1/4″ (6 mm) of insulation from each conductor of the control wire.
11. Insert the stripped wires in the remote disable terminal block and tighten the screws.
12. If the terminal block was removed, reattach it by tightening the two mounting screws.

Operation

SYSTEM STARTUP PROCEDURE

WARNING:

Before turning on the inverter, ensure that the front panels are closed properly.

AVERTISSEMENT:

Assurez-vous de la bonne fermeture des panneaux antérieurs avant de mettre l'onduleur en route.

To Start the Inverter

1. Turn the ON/OFF switch to the **OFF** position.

   The ON/OFF switch is located next to the display screen.
2. Check the polarity of the DC positive and negative connectors to ensure they are wired correctly.
3. Confirm the PV panel open circuit voltage is at or below 600 VDC.
4. Close all upper and lower cabinet doors.
5. Turn on the external AC connection to the inverter.
6. Turn the inverter's AC disconnect to the power ON position.

   The display on the upper front panel should now be active.

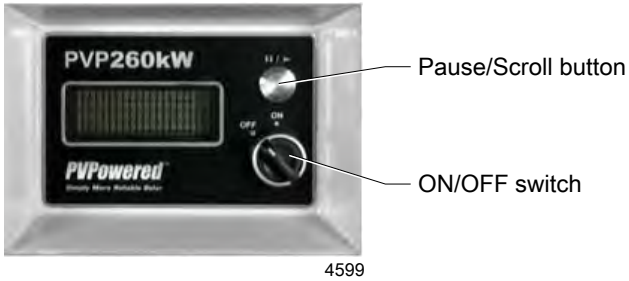


Figure 5-1. Inverter display

7. Turn on the external DC disconnect to provide DC power to the inverter.
8. Turn the inverter's DC disconnect to the power ON position.

9. Turn the ON/OFF switch to the **ON** position.

   After five minutes, the inverter starts to produce power into the AC grid if all necessary operating conditions are met.

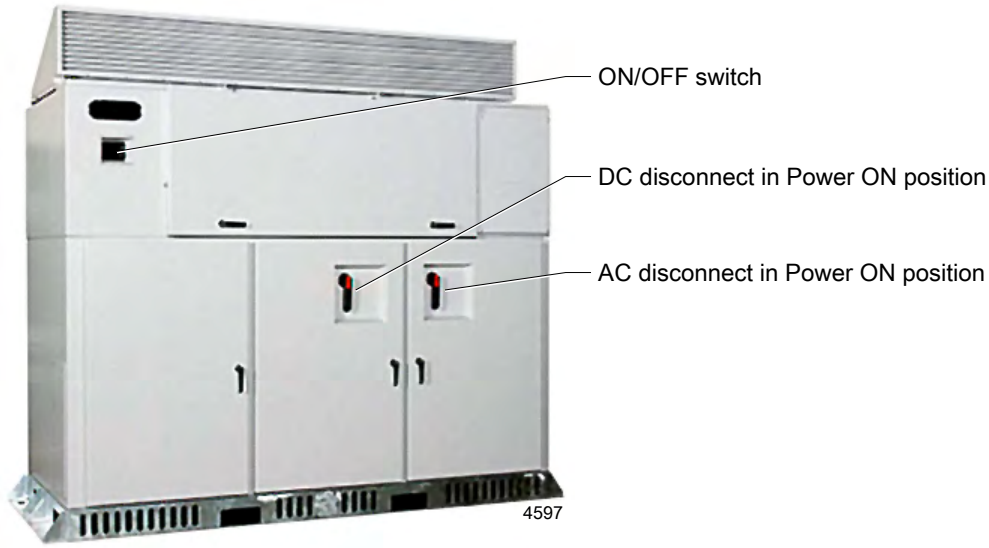


Figure 5-2. *Inverter with AC and DC disconnect power ON*

If the unit fails to power on, use the troubleshooting information provided in this manual. If those steps do not resolve the problem, contact your service provider or AE Solar Energy Technical Support.

INVERTER OPERATING STATES

The PVP250kW/PVP260kW inverter has nine operating states. The inverter will transition from one state to another only as shown in the following figure. Each operating state is described below.

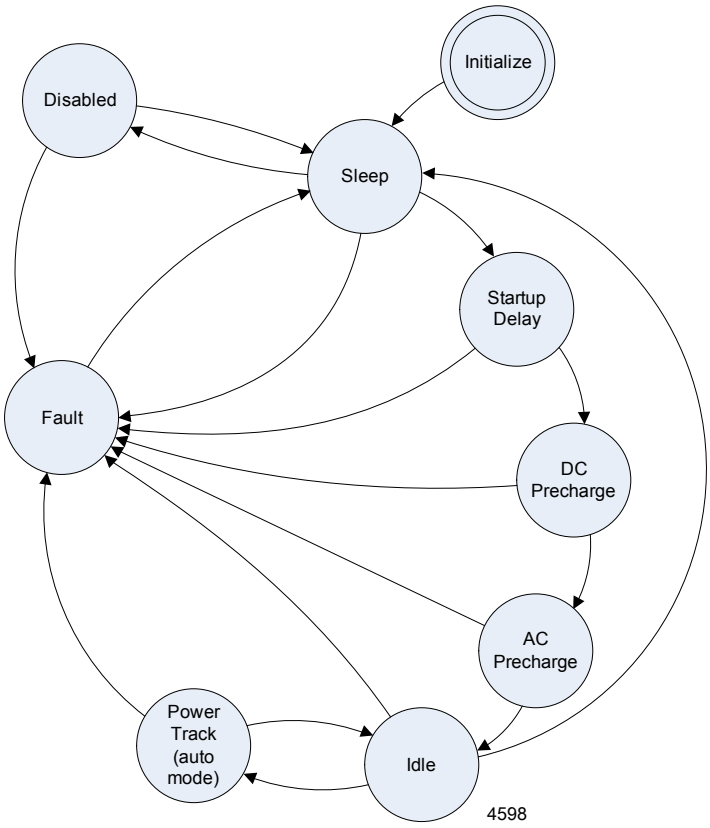


Figure 5-3. Inverter state diagram

- Initialize: The inverter enters this state after a power cycle. Variables and devices are initialized and I/O ports set. When initialization is complete, the inverter enters the sleep state.
- Disabled: The inverter enters this state when the front-panel switch is in the **OFF** position or when a disable command is received over the Modbus connection. If a fault condition occurs, the inverter switches to the fault state. When the fault is cleared and the condition no longer exists, the inverter returns to the disabled state. The inverter displays a message on the screen indicating the inverter is disabled. When an enable command is received or the front-panel switch is changed to the **ON** position, the inverter switches to the sleep state. The inverter will also enter the disabled state when the remote disable input feature is applied.
- Fault: The inverter enters this state when any fault condition occurs. The inverter can enter this state from any other state except initialize. Unless the fault is latching, the inverter clears the fault when the fault condition subsides. The inverter displays the fault codes and messages indicating the current fault conditions. If the fault is latching, the inverter switches to the latched fault state. The inverter enters this state when a latching fault condition occurs. The inverter displays fault codes and messages indicating the current fault conditions. When the fault is cleared, the inverter switches to the sleep state. Descriptions of the inverter faults are included in the Troubleshooting chapter.

- Sleep: In this state, the inverter is enabled but the DC voltage is below the minimum operating window. When the PV input voltage rises above the starting voltage, the inverter switches to the startup delay state.
- Startup Delay: In this state, the inverter delays a specified time and then enters the DC precharge state. The delay depends on the conditions prior to the sleep state and the time taken to reach this state from the previous shutdown. If a grid interactive fault occurred on the previous shutdown, the inverter will remain in this state for five minutes.
- DC Precharge: In this state, the inverter closes the DC precharge-contactor, which limits inrush current into the DC bus capacitors. When the DC bus voltage reaches the PV input voltage and is greater than the DC start voltage, the inverter switches to the AC precharge state.
- AC Precharge: In this state, the inverter closes the main DC contactor and the AC precharge-contactor, which limits inrush current into the transformer. Once the transformer is magnetized, the main AC contactor is closed and the AC pre-charge contactor is opened. After a short delay the inverter switches to the idle state.
- Idle: In this state, the inverter stops energy conversion and displays a message indicating that the inverter is idle. The inverter switches to the power tracking state when the DC voltage is above the DC start voltage. If a fault condition occurs, the inverter switches to the fault state. If the DC voltage drops below the minimum, the inverter switches to the sleep state.
- Power Track: In this state, the inverter operates in voltage control mode using the maximum power point tracking (MPPT) function. If a fault occurs, the inverter switches to the fault state.

Related Links

- “Troubleshooting and Solar Energy Technical Support” on page 8-1

DISPLAY SCREENS AND OPERATION

The digital display located on the front of the AE inverter includes both a scrolling display screen and buttons for operating. The display provides the unit operator with information about the current state of the inverter.

There are five sets of screens that may display depending on the state of the inverter. The five sets are:

- Initialize: The initialize state is displayed on the screen when the inverter is first turned on.
- Energy tracking: These are the normal power production states of idle, run, and AC and DC precharge. Following the startup delay, the inverter goes to energy tracking which starts with the DC and AC precharge and then goes to idle and run.

- Fault
- Warning
- Disabled

The display screens for each state are shown in the following figures. When there is a series of display screens associated with the inverter state then the inverter will continuously scroll through these screens.

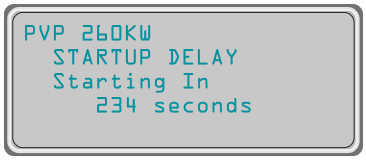


Figure 5-4. *Initialize state screen*

Screen 1: Product | Screen 2: State | Screen 3: DC values

Screen 4: AC values | Screen 5: Power values

Figure 5-5. *Energy tracking state screens*

☞ **Important**

The DC current display is not a precise measurement.

Screen 1: Fault code(s) | Screen 2: Fault text | Screen 3: Contact information

Figure 5-6. *Fault state screens*

Figure 5-7. *Warning state screen*

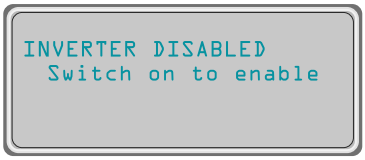


Figure 5-8. Disabled state screen

To Operate the Display

The inverter display scrolls through a series of display screens based on the current state of the inverter. To operate the display:

- Press the **Pause/Scroll** button to pause the display on a specific screen
- Press the **Pause/Scroll** button again to resume the scroll function

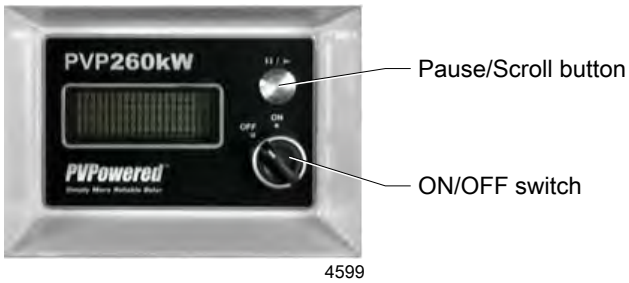


Figure 5-9. Inverter display and switch

☞ **Important**
The ON/OFF switch disables the inverter, turning off inverter output power.

GROUND FAULT INTERRUPT DEVICE

The inverter is equipped with a ground fault detector interrupter (GFDI). The purpose of the GFDI is to detect a ground fault (unintended current flow from the solar panels to earth ground) and in this event, disable the inverter.

The GFDI functions using a 5 A fuse to connect or bond the solar array negative (or the solar array positive, if using a positively grounded panel array) to earth ground.

If the ground fault current exceeds 5 A between the grounded array terminal and the earth ground, the fuse will open and disconnect the solar panels from their ground reference, interrupting the ground fault. In this situation, the inverter will cease operation and display a fault message.

To Respond to a Ground Fault

WARNING:

For the GFDI circuit to function as designed, the solar array safety ground must not be connected to the PV array positive or negative leads. Bonding the safety ground to the grounded leg of the array anywhere but through the inverter will cause the GFDI circuit to be bypassed. This would defeat the operation of the GFDI and potentially create an unsafe operating condition.

AVERTISSEMENT:

Pour que le circuit GFDI fonctionne normalement, la prise de terre de sécurité du système PV ne doit pas être branché aux câbles positifs ou négatifs des piles PV. Brancher la prise de terre de sécurité au pied des piles ou à toute autre partie que l'onduleur causerait une mise hors circuit du GFDI. Ceci ne empêcherait le fonctionnement normale du circuit GFDI et créerait des conditions de fonctionnement potentiellement dangereuses.

- If the inverter displays a ground fault as shown in the following figure turn off the AC and DC to the inverter and refer to the inverter maintenance and troubleshooting information.

  The following figure shows the inverter ground fault error message.

Figure 5-10. Ground fault error message

TO SHUTDOWN THE INVERTER

DANGER:

This unit contains energy storage devices that take up to 5 minutes to discharge. Verify the high energy capacitors are completely discharged before working on this unit.

DANGER:

Cette unité contient des dispositifs de stockage d'énergie qui prennent jusqu'à 5 minutes pour se décharger. Vérifier que les condensateurs à haute énergie sont complètement déchargés avant de travailler sur l'unité.

1. Turn the ON/OFF switch on the display to **OFF** position.
2. Turn the DC disconnect to the power OFF position by rotating the DC power lever to the position shown in the following figure.
3. Wait five minutes.
4. Turn the AC disconnect to the power OFF position by rotating the AC power lever to the position shown in the following figure.

   The display on the upper front panel should be inactive.

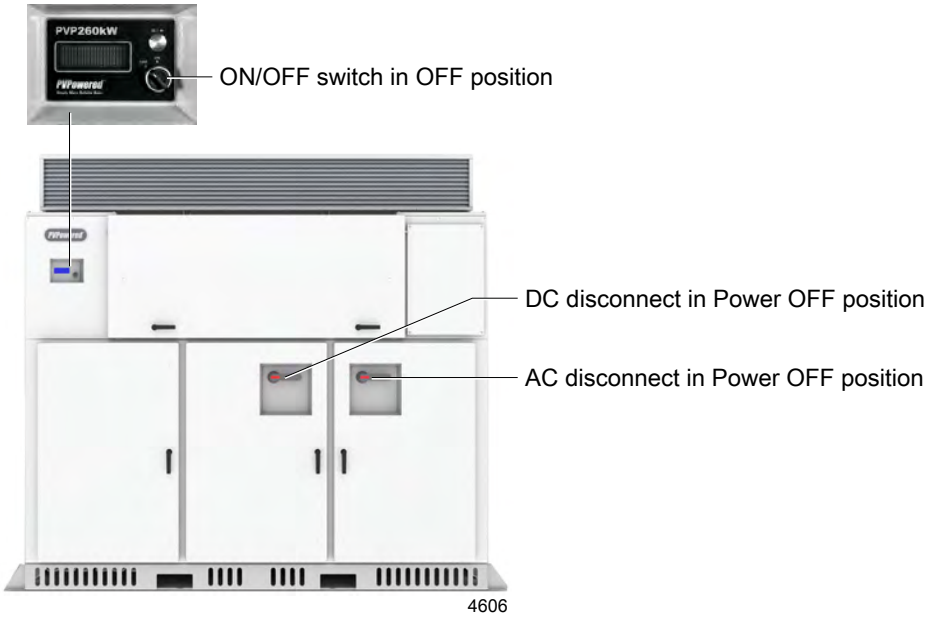


Figure 5-11. AC and DC disconnect power OFF

5. Open the utility connection circuit breaker.
6. Disconnect the PV array connection to the inverter using the external PV disconnect.

De-energize/Isolation Procedures

The following procedure should be followed to de-energize the inverter for maintenance.

TO DE-ENERGIZE THE INVERTER

DANGER:

Risk of electrical shock. When exposed to light, PV arrays create electrical energy that could cause a hazardous condition.

DANGER:

Risque d'électrocution. L'autorisation officielle de votre compagnie locale d'électricité est requise avant de brancher l'onduleur sur le réseau public. Seul le personnel qualifié est autorisé à brancher le dispositif sur le réseau public d'électricité.

DANGER:

This unit contains energy storage devices that take up to 5 minutes to discharge. Verify the high energy capacitors are completely discharged before working on this unit.

DANGER:

Cette unité contient des dispositifs de stockage d'énergie qui prennent jusqu'à 5 minutes pour se décharger. Vérifier que les condensateurs à haute énergie sont complètement déchargés avant de travailler sur l'unité.

1. Turn the inverter's ON/OFF switch to the **OFF** position.
2. Disconnect the PV array connection to the inverter using the external PV disconnect
3. Turn the DC disconnect to the power OFF position by rotating the DC power lever to the off position.

   The display on the upper front panel should be inactive.
4. Wait five minutes.
5. Turn the AC disconnect to the power OFF position by rotating the AC power lever to the off position.
6. Open the utility connection circuit breaker or the overcurrent protection device, a breaker or disconnect.
7. Install LOTO devices on the equipment as necessary to comply with LOTO requirements.

Inverter Enable/Disable Controls

The table below shows the interaction of the inverter on/off controls. Cells containing an *x* can be in either state.

Table 5-1. Inverter enable/disable

Inverter Enable/ Disable Switch	Inverter Disconnect Switches	Remote Enable/ Disable	Modbus Enable/Disable	Inverter Status
On	Closed	Enabled	Enabled	Enabled
Off	*x*	*x*	*x*	Disabled
x	Open	*x*	*x*	Disabled
x	*x*	Disabled	*x*	Disabled
x	*x*	*x*	Disabled	Disabled

Data Monitoring and Controls

NETWORKING AND PERFORMANCE MONITORING

The inverter has an integrated data monitoring module located in the dedicated data monitoring compartment. The data monitoring module enables access to the inverter performance data using the following methods:

- Basic performance data can be accessed using a free web-based monitoring service provided by AE.
- The data monitoring module can deliver data to a third party monitoring system through a Modbus/TCP over an Ethernet network, or Modbus/RTU over an RS-485 network.

OVERVIEW OF THE COMMUNICATIONS INTERFACE BOARD

The communications interface PCB shown in the following illustration is a standard feature in every inverter.

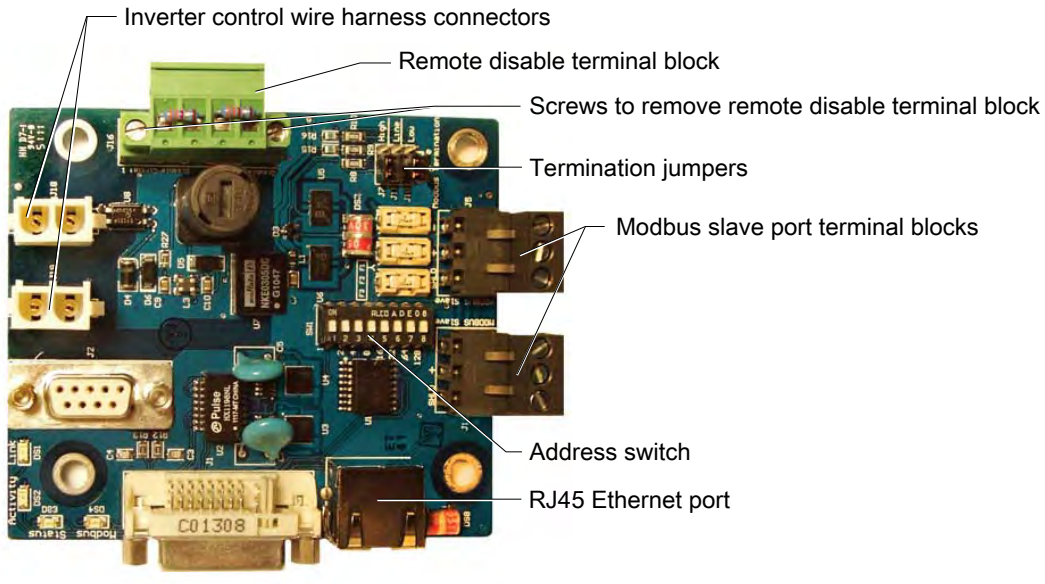

Inverter control wire harness connectors
Remote disable terminal block
Screws to remove remote disable terminal block
Termination jumpers
Modbus slave port terminal blocks
Address switch
RJ45 Ethernet port

Figure 6-1. Communications interface PCB

The primary purpose of the communications interface PCB is to provide a means to communicate with the inverter through either Modbus RTU or Modbus TCP/IP. These connections can be used for third party monitoring or for web-based inverter monitoring through AE's mypvpower.com (which uses a proprietary Ethernet protocol).

The communications interface PCB provides the following:

- Remote disable capabilities, which allow the inverter to be disabled through external methods such as an e-stop, generator interlock, or fire alarm panel
- Binary Modbus device addressing
- Additional Modbus slave port terminal block, which makes it easier to run an RS-485 daisy-chain network

Inverters with the old Comm X PCB do not support the remote disable feature or other features associated with the communications interface PCB. To determine whether a specific inverter has the communications interface PCB, visually inspect the communication board in the unit to see if the remote disable terminal block is present, and the wire harness is connected to the inverter control wire harness connectors located at the edge of the board.

DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.

DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.

If you have questions about the capabilities of a specific unit, contact AE Solar Energy Technical Support.

Ethernet Network Connection

An Ethernet connection can be used to connect the unit to the internet, or to a local Modbus/TCP network not connected to the internet. AE offers a free basic monitoring service through the solarenergy.advanced-energy.com website. Internet service must be set up at the installation site before the inverter can be accessed online. The data monitoring module supports only hard-wired CAT5 solutions to the inverter. The module does NOT support wireless configurations. To access the data monitoring information, customers need to provide a broadband Ethernet connection to the inverter, based on the following specifications:

- Provide a DHCP-enabled, or static IP based broadband internet connection that is always ON. This can be cable internet, a DSL line, or equivalent.
- Provide a hard-wired, Ethernet connection between the communications interface PCB in the inverter and the closest site LAN connection.
  - If multiple inverters are commissioned to a single site, an Ethernet hub can be located in an outdoor-rated enclosure to distribute the LAN to the inverters.

☞ **Important**

The data monitoring module does not support dial-up modem connectivity.

☞ **Important**

Some complex networks may require a system administrator to add the inverter to the network, or to configure the unit to a static IP address.

All AE commercial inverters come standard with an Ethernet port that is intended to be connected to the Internet or to a local area network for Modbus/TCP. The commercial inverter operates as an Internet appliance. The inverter communicates with the AE data center using https (port 443). Communications is one way – the inverter only communicates externally to the AE data center. Typically the inverter posts approximately 50 kB of data to the data center every 15 minutes. The inverter may post data more frequently for a short period of time if there is an inverter fault.

Connecting the Ethernet Cable

PARTS OR TOOLS REQUIRED

You need the following parts and/or tools to make the Ethernet cable connection:

- Ethernet LAN cable (Category 5 or above)
- RJ45 modular connector plugs
- Appropriate conduit fitting
- Ethernet hub, switch or router to provide network connectivity
- Cable tester

TO MAKE THE INVERTER'S ETHERNET CONNECTION

Use the following steps to complete the connection of the Ethernet cable to the inverter's communication interface PCB:

1. Route the Ethernet (CAT5) cable from the Internet-enabled router, at the gland plate location on the upper right side of the inverter, using the proper conduit and hub connectors.

   ☞ **Important**

   The Ethernet cable must comply with T-568B standards as shown in the following figure. This is the only configuration supported by the data monitoring module. Other wiring configurations will not work.

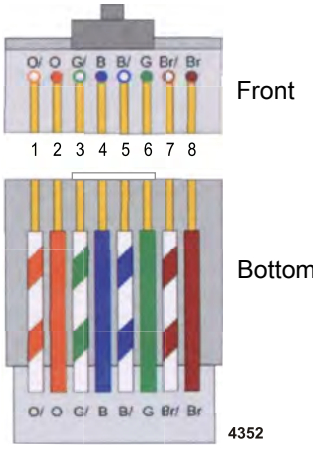


Figure 6-2. T-568B compliant Ethernet cable

2. Plug the Ethernet cable into the Ethernet port on the communication interface PCB located in the data monitoring section of the inverter. Refer to the following figure for the port location.

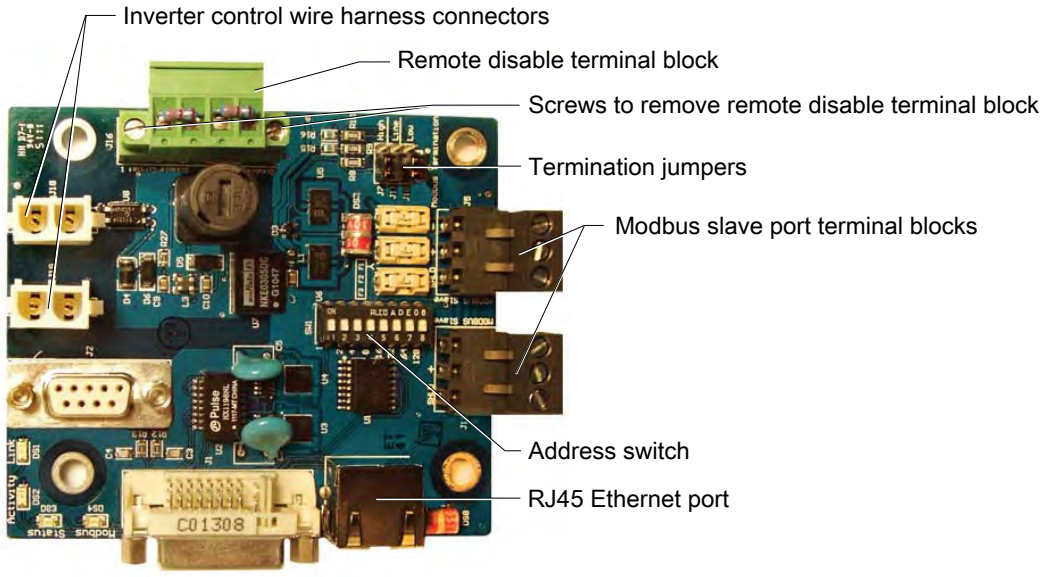

Inverter control wire harness connectors
Remote disable terminal block
Screws to remove remote disable terminal block
Termination jumpers
Modbus slave port terminal blocks
Address switch
RJ45 Ethernet port

Figure 6-3. Communication interface PCB Ethernet port location

Related Links

- "Conduit Entry Points" on page 4-9

To Establish an Internet Connection with the Inverter

Below is a list of requirements to establish inverter communications with the AE data center. Connectivity must be established before registration on the site is attempted.

1. Connect the inverter's Ethernet port to a hub or router using an Ethernet cable.

Ethernet cables must meet the T-568B wiring standard and must be less than 320 feet in length. If a longer cable is needed additional networking hardware may be required.

2. Provide DHCP server access to the inverter and provide a path to the Internet for https (port 443) from the inverter.

   As shipped, the inverter requires DHCP to establish its IP address. Contact AE Solar Energy Technical Support if a fixed IP address is required for your network.

3. Locate the inverter's MAC address on the label on the communications interface PCB.

When the Internet connection is established, go to the AE web site and navigate to the PVP Commercial Monitoring page to register the inverter and begin using the monitoring tools. Contact AE Solar Energy Technical Support if additional information is needed on how to use the online tool.

To Verify Data Monitoring Connectivity

Verify connectivity using the following information:

1. Check the status light located on the front of the communication PCB in the card cage on the right side of the upper compartment in the data monitoring section.

   If the green status light is in a solid on state, the data monitoring connection is established. If the status light is not solid, troubleshoot the connection.

2. Register the inverter at the AE Solar Energy web site to complete the setup for monitoring the inverter.

Related Links

- “Troubleshooting and Solar Energy Technical Support” on page 8-1

MODBUS OVERVIEW

The PVP250kW and PVP260kW inverter can communicate via Modbus/TCP or Modbus/RTU.This chapter is written for PV installers, electricians, controls contractors, and Modbus network programmers.

Modbus Communication Protocol

Modbus is a serial communications protocol and is the most commonly used means of monitoring and communicating between devices in the PV industry. The Modbus protocol allows for communication between a Modbus master device and multiple Modbus slave devices connected to the same network. The physical layer for

Modbus/TCP is a CAT5 Ethernet network. Modbus/RTU uses a twisted pair shielded conductor RS-485 network.

NETWORKING USING THE MODBUS OPTION

The following steps are required to set up a Modbus TCP network for your AE inverter:

- Field installation : This step can be completed onsite by a PV installer or an electrician that does not have working knowledge of a Modbus network
  - Consult the facility IT administrator for network device installation support and coordination
  - Install the Modbus network communications cabling
- Modbus network configuration: This step can be done onsite or remotely and should be completed by the Modbus network programmer
  - Set the IP address assigned to the inverter and port 502 for Modbus TCP
  - Configure the point maps for the slave devices

Modbus TCP Installation

Disconnect the power to the inverter before starting the installation.

TO INSTALL THE MODBUS TCP CABLE

DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.

DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.

1. Remove the data monitoring gland plate on the right side of the inverter.

   The data monitoring gland plate is a flat piece of metal covering the side entry port to the inverter's data monitoring compartment.

2. Cut a hole in the desired location to allow access for the cable.
3. Install a water-tight conduit hub connection.
4. Replace the gland plate.
5. Route an Ethernet cable from a network port in the facility that has been approved by the network administrator through the conduit hub.
6. Connect the Ethernet cable to the Ethernet port on the communication interface PCB.

   The communication interface PCB is located in the data monitoring section in the right upper compartment of the inverter.

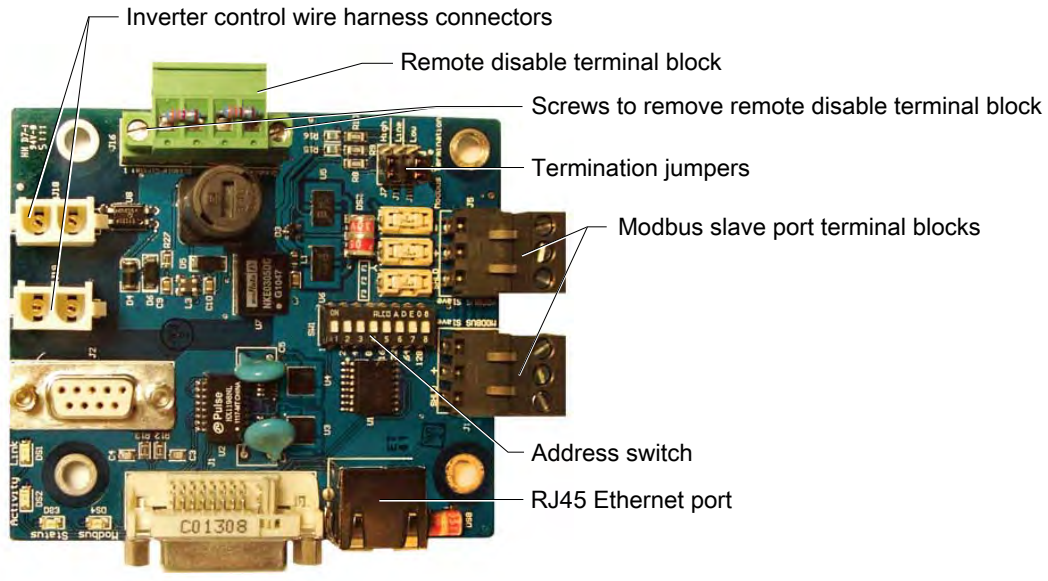

Inverter control wire harness connectors
Remote disable terminal block
Screws to remove remote disable terminal block
Termination jumpers
Modbus slave port terminal blocks
Address switch
RJ45 Ethernet port

Figure 6-4. *Communication interface PCB in the data monitoring section*

Modbus TCP Network Configuration

TO ASSIGN THE IP ADDRESS AND PORT ID

1. Contact the facility's IT Network Administrator (or person with similar responsibilities) to assign an IP address to each inverter. Advanced users can assign a static IP address.

   Contact AE Solar Energy Technical Support for assistance.
2. Set the Modbus master to communicate through port 502.

NETWORKING USING THE MODBUS RS-485 OPTION

The following steps are required to set up a Modbus RS-485 network for the AE inverter:

- Field installation : This step can be completed onsite by a PV installer or an electrician that does not have working knowledge of a Modbus network
  - Installing the Modbus network wiring
  - Configuring end-of-line termination and network biasing
  - Setting the Modbus address for each slave inverter

> ☞ **Important**
> The contractor responsible for network programming will need to provide the slave addresses prior to setting the Modbus address for each slave inverter.

The final part of the RS-485 installation process is the Modbus network configuration. These steps should be completed by the Modbus network programmer. The last two steps are:

- Setting the device addresses so the Modbus master program will accept the Modbus addresses assigned during the field installation
- Configuring point maps for slave devices

Network Layout

When multiple inverters or other Modbus slave devices are connected to a single Modbus master device, the multiple devices need to be connected in one of the three daisy chain layouts shown in the following figure.

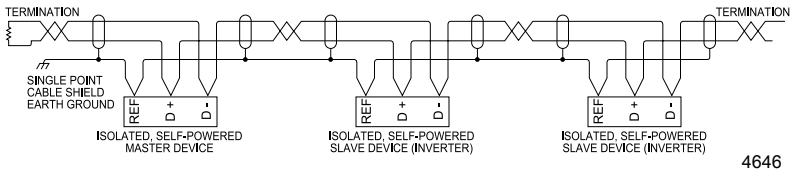


Figure 6-5. Daisy chain layout for RS-485 network: option A

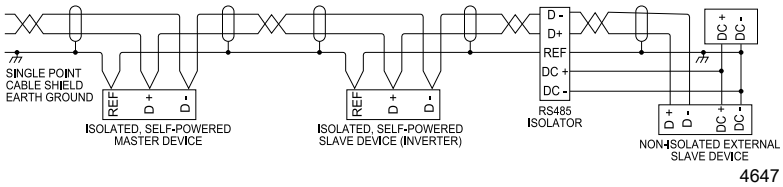


Figure 6-6. Daisy chain layout for RS-485 network: option B

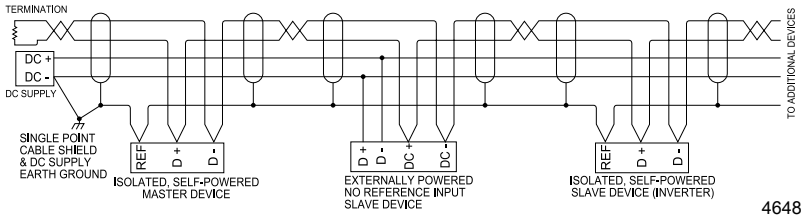


Figure 6-7. Daisy chain layout for RS-485 network: option C

Important

When multiple devices are wired to the network, the network shield must be terminated to earth ground at one point on the network, typically at the beginning or the end. For device connections the shield must be rewired to provide a continuous shield and isolated from ground.

Modbus Wiring for the Communications Interface PCB

The communications interface PCB includes two Modbus slave port terminal blocks. The two Modbus slave port terminal blocks can be used in an in-and-out configuration for daisy-chain networking. The two terminal blocks are electrically bonded on the PCB. Therefore, it does not matter which one is used or the order in which they are connected. The following illustration provides an example of how the two terminal blocks can be used.

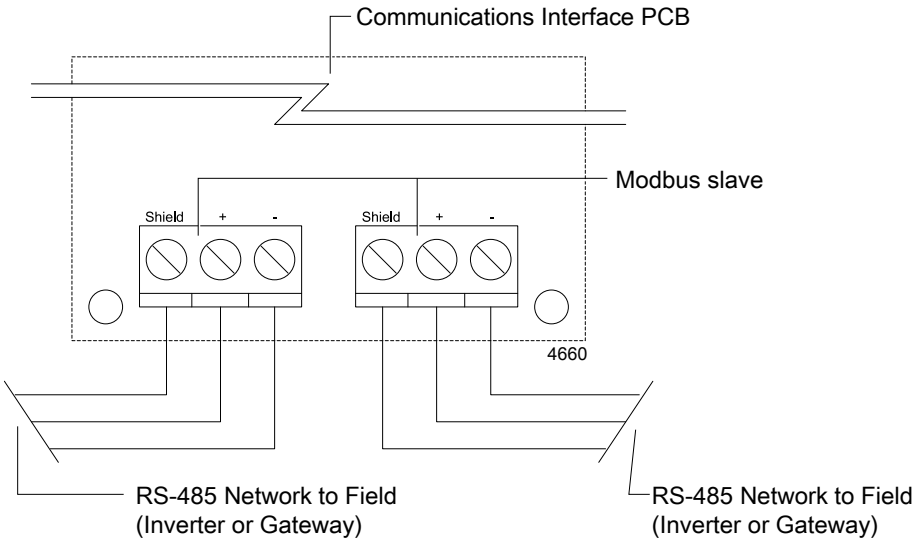


Figure 6-8. Example connection with dual Modbus slave port terminal blocks

Installing the Modbus RS-485 Cable

MODBUS RS-485 WIRING REQUIREMENTS

The Modbus RTU connections are made using shielded, insulated, 18-24 gauge twisted-pair communication cable that has a characteristic impedance of 120 ohms. If

the RS-485 network will not pass through any high voltage (> 300 V) areas, then 300 V rated cable may be used in the low voltage data monitoring compartment of the inverter. Check with your local inspector or project engineer if you need assistance in determining this requirement. Some appropriate 300 V data cables include:

- Belden 3105A (1P22AWG shielded)
- Belden 3082A (1P15AWG + 1P18AWG shielded)

Belden 7897A (1P15AWG + 1P18AWG shielded) is an example of a 600 V rated cable that may also be used; others exist as well.

TO INSTALL THE MODBUS RS-485 CABLE

DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.

DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.

1. Disconnect the power to the inverter before starting the installation.
2. Remove the data monitoring gland plate on the upper right side of the inverter.

   The data monitoring gland plate is a flat piece of metal covering the side entry port to the inverter's data monitoring compartment.
3. Punch or drill a hole in the desired location to allow access for the cable.
4. Install a water-tight conduit hub connection.
5. Replace the gland plate.
6. Route a RS-485 cable from the master device on the Modbus network port in the facility that has been approved by the network administrator through the conduit hub.
7. Connect each Modbus cable to a slave port terminal block on the communications interface PCB. Connect the plus (+) cables to plus (+) connections and the minus (-) cables to minus (-) connections so they correspond throughout the network.

   The Modbus slave port terminal blocks can be unplugged for easy wiring access.

☞ **Important**

Observe and maintain correct polarity and wiring orientation.

Note: Two slave port terminal blocks, wired in parallel, are available to simplify wiring in a daisy-chain network.

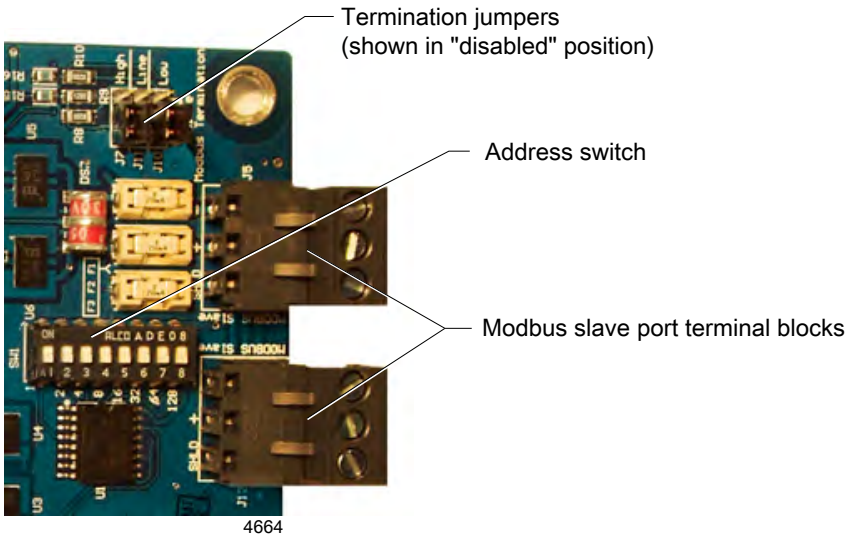


Figure 6-9. *Communications interface PCB with Modbus slave port location*

8. Connect a ground reference line to the terminal labeled **SHLD**

   The shield of a communications cable may be used for this reference as long as the shield is connected to earth ground at one point only. AE recommends that all AE inverters have connected grounds when possible.

   ☞ **Important**

   Some Modbus devices do not have a shield or reference input. In these cases the device most often uses the DC power supply (-) as the RS-485 reference. It may be necessary to place an RS-485 isolator on these devices or power them from a common DC supply that has its DC (-) referenced to earth ground at the same point where the network cable shield is earthed.

Setting the Jumper Pins

By default, the termination pins have three jumpers in the disabled position when the inverter is shipped. The location of the jumpers can determine the following settings for an inverter:

- Terminate the network
- Determine the center inverter(s) on the network
- Turn on biasing

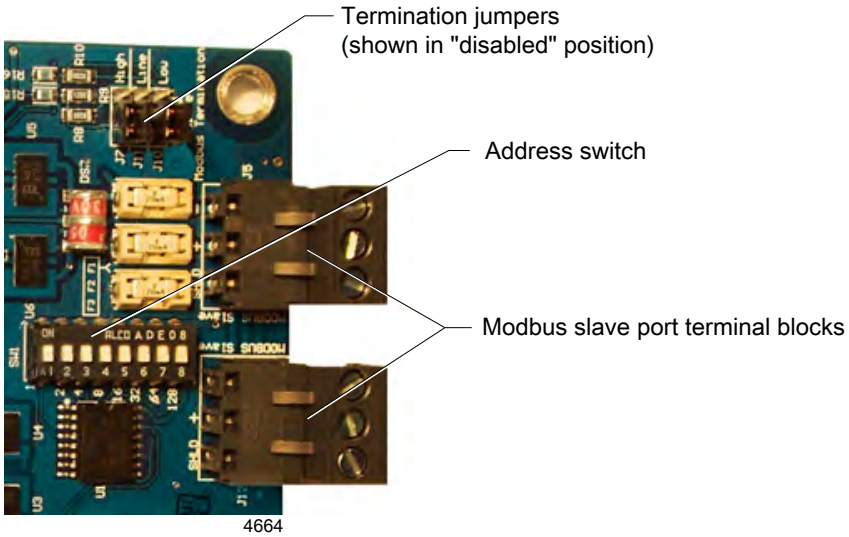


Figure 6-10. *Termination jumpers on the communications interface PCB*

The performance of your Modbus network may require each end of the network to be terminated using 120 Ω termination resistors. When the network is long, relative to the RS-485 bit rate in use, bus terminations must be installed. The network length is determined by the total backbone cable length and not necessarily the line-of-sight between the two furthest apart devices.

Table 6-1. *Maximum network length per Modbus bit rate*

RS-485/Modbus Bit Rate	Maximum Network Length Without Termination in Feet (Meters)	Maximum Network Length With Termination in Feet (Meters)
9600 bps	1000 (305)	4000 (1200)
19,200 bps	500 (152)	4000 (1200)
38,400 bps	250 (76)	4000 (1200)
57,600 bps	150 (46)	4000 (1200)

TO TERMINATE THE INVERTER NETWORK

If bus termination is desired and the inverter is on the end of the Modbus network, you need to set the termination.

1. Verify that the J7 jumper is in the lowe, NC position.
2. Move the jumper to the upper pair of J11 pins labeled **Line**.
3. Verify that the J10 jumper is in the lower NC position.

Table 6-2. Termination enabled for end device

Termination	Disabled	Enabled
High (J7)	X	
Line (J11)		X
Low (J10)	X	

TO SET THE CENTER INVERTERS FOR THE NETWORK

Inverters in the center of the network need the termination jumpers set to the disabled position.

1. Verify that the J7 jumper is in the lower NC position.
2. Verify that the J11 jumper is in the lower NC position.
3. Verify that the J10 jumper is in the lower NC position.

Table 6-3. No termination or biasing (default setting)

Termination	Disabled	Enabled
High (J7)	X	
Line (J11)	X	
Low (J10)	X	

TO SET NETWORK BIASING

Biasing sets the voltage levels on the data lines of an inactive or idle network. At least one device on the network must provide biasing. On shorter networks with fewer installed devices, biasing may only be needed on the device furthest away from the master. Longer networks that are terminated on both ends may require two devices to have their biasing enabled.

To Set the Jumpers to Use the Inverter's Built-in Biasing

1. Move the jumper to the upper pair of J7 pins labeled **High**.
2. Verify that the J11 jumper is in the lower NC position.
3. Move the jumper to the upper pair of J10 pins labeled **Low**.

Table 6-4. Biasing enabled

Termination	Disabled	Enabled
High (J7)		X

Table 6-4. Biasing enabled (Continued)

Termination	Disabled	Enabled
Line (J11)	X	
Low (J10)		X

TO TERMINATE THE NETWORK AND ENABLE BIASING

As an alternative, an end inverter on the network can require both termination and biasing to be enabled. Set the following jumpers to configure the inverter for both settings.

1. Move the jumper to the upper pair of J7 pins labeled **High**.
2. Move the jumper to the upper pair of J11 pins labeled **Line**
3. Move the jumper to the upper pair of J10 pins labeled **Low**.

Table 6-5. Biasing and termination enabled (for end device)

Termination	Disabled	Enabled
High (J7)		X
Line (J11)		X
Low (J10)		X

Setting the Modbus Address

A Modbus network containing slave devices requires a unique address for each slave. These unique addresses allow the master device to identify and communicate with each slave. The Modbus network administrator must assign a unique Modbus address to each AE inverter.

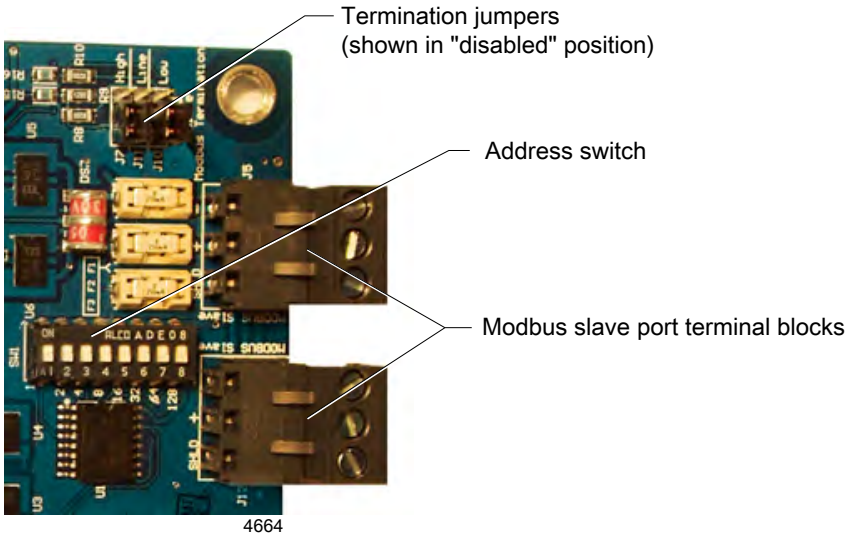


Figure 6-11. Setting the inverter Modbus address

TO SET THE MODBUS ADDRESS

1. Remove the communications PCB from the card cage to access the address switch.
2. Determine each slave address.
3. Set the address on each slave device.

   The slave address for each inverter is set using a binary coded DIP switch.

   ☞ **Important**
   0 is not an allowed address.

   ☞ **Important**
   Some Modbus master devices do not allow addresses above the decimal value of 126. AE recommends keeping the slave id number between 2 and 100.

Device Addressing Example

Each inverter must be set to a unique address specified by the site monitoring contractor. The address is set using a binary code on the address DIP switch.

To set an inverter to an address of 25:

1. Find the desired address in the left hand column of the table below labeled “Unit Address”.
2. Identify which switches, by switch number, must be set to the **ON** position.

   For example, an address of 25 requires switch numbers **1**, **8**, and **16** to **ON**.
3. Once the switches are set in the **ON** position, the switch should look like the figure below.

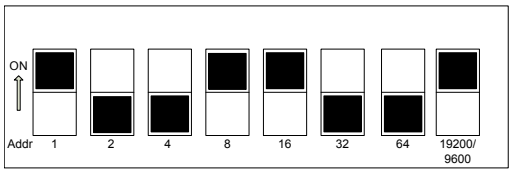


Figure 6-12. Example: Unit address switch set to address 25

If you need more device addresses than the 80 provided in the following table, refer to a complete digital to binary conversion table.

Table 6-6. Inverter address table

Unit Address (decimal)	Switch Number							
	1	2	3	4	5	6	7	8
	Switch Address							
	1	2	4	8	16	32	64	128
1	**ON**	Off	Off	Off	Off	Off	Off	Off
2	Off	**ON**	Off	Off	Off	Off	Off	Off
3	**ON**	**ON**	Off	Off	Off	Off	Off	Off
4	Off	Off	**ON**	Off	Off	Off	Off	Off
5	**ON**	Off	**ON**	Off	Off	Off	Off	Off
6	Off	**ON**	**ON**	Off	Off	Off	Off	Off
7	**ON**	**ON**	**ON**	Off	Off	Off	Off	Off
8	Off	Off	Off	**ON**	Off	Off	Off	Off
9	**ON**	Off	Off	**ON**	Off	Off	Off	Off
10	Off	**ON**	Off	**ON**	Off	Off	Off	Off
11	**ON**	**ON**	Off	**ON**	Off	Off	Off	Off
12	Off	Off	**ON**	**ON**	Off	Off	Off	Off
13	**ON**	Off	**ON**	**ON**	Off	Off	Off	Off
14	Off	**ON**	**ON**	**ON**	Off	Off	Off	Off
15	**ON**	**ON**	**ON**	**ON**	Off	Off	Off	Off
16	Off	Off	Off	Off	**ON**	Off	Off	Off
17	**ON**	Off	Off	Off	**ON**	Off	Off	Off
18	Off	**ON**	Off	Off	**ON**	Off	Off	Off
19	**ON**	**ON**	Off	Off	**ON**	Off	Off	Off
20	Off	Off	**ON**	Off	**ON**	Off	Off	Off
21	**ON**	Off	**ON**	Off	**ON**	Off	Off	Off
22	Off	**ON**	**ON**	Off	**ON**	Off	Off	Off
23	**ON**	**ON**	**ON**	Off	**ON**	Off	Off	Off

Table 6-6. Inverter address table (Continued)

Unit Address (decimal)	Switch Number							
	1	2	3	4	5	6	7	8
	Switch Address							
	1	2	4	8	16	32	64	128
24	Off	Off	Off	**ON**	**ON**	Off	Off	Off
25	**ON**	Off	Off	**ON**	**ON**	Off	Off	Off
26	Off	**ON**	Off	**ON**	**ON**	Off	Off	Off
27	**ON**	**ON**	Off	**ON**	**ON**	Off	Off	Off
28	Off	Off	**ON**	**ON**	**ON**	Off	Off	Off
29	**ON**	Off	**ON**	**ON**	**ON**	Off	Off	Off
30	Off	**ON**	**ON**	**ON**	**ON**	Off	Off	Off
31	**ON**	**ON**	**ON**	**ON**	**ON**	Off	Off	Off
32	Off	Off	Off	Off	Off	**ON**	Off	Off
33	**ON**	Off	Off	Off	Off	**ON**	Off	Off
34	Off	**ON**	Off	Off	Off	**ON**	Off	Off
35	**ON**	**ON**	Off	Off	Off	**ON**	Off	Off
36	Off	Off	**ON**	Off	Off	**ON**	Off	Off
37	**ON**	Off	**ON**	Off	Off	**ON**	Off	Off
38	Off	**ON**	**ON**	Off	Off	**ON**	Off	Off
39	**ON**	**ON**	**ON**	Off	Off	**ON**	Off	Off
40	Off	Off	Off	**ON**	Off	**ON**	Off	Off
41	**ON**	Off	Off	**ON**	Off	**ON**	Off	Off
42	Off	**ON**	Off	**ON**	Off	**ON**	Off	Off
43	**ON**	**ON**	Off	**ON**	Off	**ON**	Off	Off
44	Off	Off	**ON**	**ON**	Off	**ON**	Off	Off
45	**ON**	Off	**ON**	**ON**	Off	**ON**	Off	Off
46	Off	**ON**	**ON**	**ON**	Off	**ON**	Off	Off
47	**ON**	**ON**	**ON**	**ON**	Off	**ON**	Off	Off
48	Off	Off	Off	Off	**ON**	**ON**	Off	Off
49	**ON**	Off	Off	Off	**ON**	**ON**	Off	Off
50	Off	**ON**	Off	Off	**ON**	**ON**	Off	Off
51	**ON**	**ON**	Off	Off	**ON**	**ON**	Off	Off
52	Off	Off	**ON**	Off	**ON**	**ON**	Off	Off
53	**ON**	Off	**ON**	Off	**ON**	**ON**	Off	Off

Table 6-6. Inverter address table (Continued)

Unit Address (decimal)	Switch Number							
	1	2	3	4	5	6	7	8
	Switch Address							
	1	2	4	8	16	32	64	128
54	Off	**ON**	**ON**	Off	**ON**	**ON**	Off	Off
55	**ON**	**ON**	**ON**	Off	**ON**	**ON**	Off	Off
56	Off	Off	Off	**ON**	**ON**	**ON**	Off	Off
57	**ON**	Off	Off	**ON**	**ON**	**ON**	Off	Off
58	Off	**ON**	Off	**ON**	**ON**	**ON**	Off	Off
59	**ON**	**ON**	Off	**ON**	**ON**	**ON**	Off	Off
60	Off	Off	**ON**	**ON**	**ON**	**ON**	Off	Off
61	**ON**	Off	**ON**	**ON**	**ON**	**ON**	Off	Off
62	Off	**ON**	**ON**	**ON**	**ON**	**ON**	Off	Off
63	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**	Off	Off
64	Off	Off	Off	Off	Off	Off	**ON**	Off
65	**ON**	Off	Off	Off	Off	Off	**ON**	Off
66	Off	**ON**	Off	Off	Off	Off	**ON**	Off
67	**ON**	**ON**	Off	Off	Off	Off	**ON**	Off
78	Off	Off	**ON**	Off	Off	Off	**ON**	Off
69	**ON**	Off	**ON**	Off	Off	Off	**ON**	Off
70	Off	**ON**	**ON**	Off	Off	Off	**ON**	Off
71	**ON**	**ON**	**ON**	Off	Off	Off	**ON**	Off
72	Off	Off	Off	**ON**	Off	Off	**ON**	Off
73	**ON**	Off	Off	**ON**	Off	Off	**ON**	Off
74	Off	**ON**	Off	**ON**	Off	Off	**ON**	Off
75	**ON**	**ON**	Off	**ON**	Off	Off	**ON**	Off
76	Off	Off	**ON**	**ON**	Off	Off	**ON**	Off
77	**ON**	Off	**ON**	**ON**	Off	Off	**ON**	Off
78	Off	**ON**	**ON**	**ON**	Off	Off	**ON**	Off
79	**ON**	**ON**	**ON**	**ON**	Off	Off	**ON**	Off
80	Off	Off	Off	Off	**ON**	Off	**ON**	Off

MODBUS COMMANDS

Basic Modbus commands are supported on applicable AE commercial units. The commands in the following table are used to read and write (set) operating parameters or obtain the unit's identifying information.

Table 6-7. Modbus commands

Command Name	Command Number	Description
Read Holding Register	03	Read value from the register
Write (preset) Single Register	06	Write value to the register
Return Slave ID	17	Returns a text string containing the ID number of the unit. The format of the ID returned is dependent on the version of the unit. • "PVP Inverter IDxxxxxxxxxxxxx" on older models • "xxPVP Inverter IDxxxxxxxxxxxxx" for newer models

Modbus Command Format

The **Read Holding Register** command is used to read values from Modbus registers.

Table 6-8. Format for Read Holding Register command

Command Information	Command Layout
Modbus address	nn
Command number	03
First register MSB	xx
First register LSB	xx
Data MSB	xx
Data LSB	xx
CRC LSB	xx
CRC MSB	xx

Table 6-9. Response format for Read Holding Register command

Response Information	Response Layout
Modbus address	nn
Command number	03
Number of bytes of data	n
First register MSB	xx
First register LSB	xx
Second register MSB	xx
Second register LSB	xx
Nth register MSB	xx
Nth register LSB	xx
CRC LSB	xx
CRC MSB	xx

The **Write Single Register** command is used to write data to a register.

Table 6-10. Format for Write Single Register command

Command Information	Command Layout
Modbus address	nn
Command number	06
First register MSB	xx
First register LSB	xx
Nth register MSB	xx
Nth register LSB	xx
CRC LSB	xx
CRC MSB	xx

Table 6-11. Response format for Write Single Register command

Response Information	Response Layout
Modbus address	nn
Command number	06
Number of bytes of data	n
First register MSB	xx
First register LSB	xx

Table 6-11. Response format for Write Single Register command (Continued)

Response Information	Response Layout
Data MSB	xx
Data LSB	xx
CRC LSB	xx
CRC MSB	xx

Return Slave ID

The **Return Slave ID** command is used to read a text string containing the ID number of the unit.

Table 6-12. Format for Return Slave ID

Command Information	Command Layout
Modbus slave address	nn (1-126)
Command number	11h

The **Return Slave ID** command returns the ASCII string "xxPVP Inverter IDxxxxx". for example "0x50,0xFF,PVP Inverter ID02860910080321". The first "xx" represents two non-ASCII bytes, representing the following information:

- Byte 1:0x50: An identifier byte for the AE unit
- Byte 2:0x00: If communication with the unit is down, or

  0xFF: If communication with the unit is occurring
- Byte 3 through byte n: Contains "PVP Inverter IDxxxxx"

Table 6-13. Format for Return Slave ID command

Response Information	Response Layout
Modbus slave address	11h
Command number	n
Number of bytes of data	xx
Data 1	xx
Data 2	xx
Data n	xx
CRC LSB	xx
CRC MSB	xx

MODBUS DATA TYPES

Modbus data types used with the PVP250kW/PVP260kW unit are shown in the following table.

Table 6-14. Data types

Data Type	Description
ASCII	Two ASCII characters per register For a text string the left-most character is the lowest register number.
UINT16	Unsigned integer, 16 bits Range: 0 to 65,536
SINT16	Signed integer, 16 bits Range: –32,767 to +32,767
UINT 32 (requires two registers)	Unsigned integer, 32 bits Range: 0 to 4,294,967,295
SINT32 (requires two registers)	Signed integer, 32 bits Range: –2,147,483,647 to +2,147,483,647
FLOAT (requires two registers)	IEEE 754 standard 32-bit floating point number High order 16 bits in the first of the two registers. Low order 16 bits in the second register. (Big Endian)

MODBUS REGISTER MAPPING

The following tables list the Modbus registers with their location and a description of the data stored in the register.

Modbus Fixed Information Registers

Table 6-15. Modbus fixed information registers

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
Modbus base address = 0						
Inverter ID number	0	7	8	40001	ASCII	The ID number is a 16-character number that is unique for each inverter.
Inverter model number	1	2	2	40002	ASCII	The model number is extracted from four digits of the inverter ID number. Table 6-16
Firmware version	8	11	4	40009	ASCII	This register can contain up to 8 characters. Example: `V1.9`
Map version	13	13	1	40014	UINT	The range is 1 through 4. This number Increments sequentially as the map changes. All versions are backwards compatible.
Inverter configuration	14	14	1	40015	UINT	See Table 6-17 on page 6-24.
Inverter serial number	15	24	10	40016	ASCII	This register contains the serial number of the inverter (which is also on the product label). Up to 20 characters are available.
Rated power	25	25	1	40026	UINT	kW

Table 6-16. Inverter model number

Inverter Model	Modbus Model Number
PVP30kW	0272, 0273, 0274, 0288, 0289, 0290
PVP35kW	0300, 0301, 0302, 0303
PVP50kW	0304, 0305, 0306, 0307
PVP75kW	0276, 0277, 0278, 0279
PVP100kW	0280, 0281, 0282, 0283
PVP250kW	0312, 0313, 0314, 0315, 0316, 0317, 0318, 0319
PVP260kW	0312, 0313, 0314, 0315, 0316, 0317, 0318, 0319
PVP500kW	0386, 0387

Table 6-17. Bit mapping for inverter configuration register

Inverter Configuration	Bit Mapping	Instructions
AC volts = 208	0x0001	
AC volts = 240	0x0002	
AC volts = 480	0x0004	
AC volts = 600	0x0200	
Transformer tap position	0x0008	This bit is: • Set if the tap is at 265 V • Clear if the tap is 295 V The default is 295 V.
Transformer wiring configuration	0x0010	This bit is: • Set if the inverter is wired as delta • Clear if the inverter is wired as wye The default is wye.
Utility meter installation flag	0x0100	This bit is: • Set if the meter is installed • Clear if the meter is not installed The default is not installed.

Modbus Data Registers

Table 6-18. Modbus data registers

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
Modbus base address = 1000						
VoltsA L-N	1000	1001	2	41001	FLOAT	± 32 bit IEEE 754
VoltsB L-N	1002	1003	2	41003	FLOAT	± 32 bit IEEE 754
VoltsC L-N	1004	1005	2	41005	FLOAT	± 32 bit IEEE 754
Current A	1006	1007	2	41007	FLOAT	± 32 bit IEEE 754
Current B	1008	1009	2	41009	FLOAT	± 32 bit IEEE 754
Current C	1010	1011	2	41011	FLOAT	± 32 bit IEEE 754
DC input voltage	1012	1013	2	41013	FLOAT	± 32 bit IEEE 754
DC input current (see note)	1014	1015	2	41015	FLOAT	± 32 bit IEEE 754
Line frequency	1016	1017	2	41017	FLOAT	± 32 bit IEEE 754
Line kW	1018	1019	2	41019	FLOAT	± 32 bit IEEE 754
Total kWh delivered	1020	1021	2	41021	UDINT	0 to 4.29e9
PV input voltage	1022	1023	2	41023	FLOAT	± 32 bit IEEE 754
DC kW (calculated)	1024	1025	2	41025	FLOAT	± 32 bit IEEE 754
Time since epoch	1026	1027	2	41027	FLOAT	Seconds since 01/01/1970
Total kWh	1028	1029	2	41029	UDINT	± 32 bit IEEE 754

Modbus Status and Fault Code Registers

The following table provides information about the registers that are used to report status and fault codes. Each of these registers provides information about a group of status codes or faults. For more information on the specific faults that can be reported for each of the fault registers, see the troubleshooting information for the inverter. For more information about the status codes, see Table 6-20 on page 6-27 and Table 6-21 on page 6-27.

Table 6-19. Modbus status and fault code registers

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
Modbus base address = 2000						
Inverter operating status (state)	2100	2100	1	42101	UINT	See Table 6-20 on page 6-27.
Main fault	2101	2101	1	42102	UINT	See the fault codes descriptions in the inverter troubleshooting information.
Drive fault	2102	2102	1	42103	UINT	See the fault codes descriptions in the inverter troubleshooting information.
Voltage fault	2103	2103	1	42104	UINT	See the fault codes descriptions in the inverter troubleshooting information.
Grid fault	2104	2104	1	42105	UINT	See the fault codes descriptions in the inverter troubleshooting information.
Temperature fault	2105	2105	1	42106	UINT	See the fault codes descriptions in the inverter troubleshooting information.
System fault	2106	2106	1	42107	UINT	See the fault codes descriptions in the inverter troubleshooting information.
System warnings	2107	2107	1	42108	UINT	See the fault codes descriptions in the inverter troubleshooting information.
PVM (PV Monitoring) status codes	2108	2108	1	42109	UINT	See Table 6-21 on page 6-27.

The following table contains the bitmap information for the inverter operating status register. The response values for this command are shown in the bale as both hex and decimal values.

Table 6-20. Modbus inverter operating status register values

Description	Hex Value	Decimal Value
Modbus register number = 42101		
Sleep state	0	0
Startup delay state	1	1
AC precharge state	2	2
DC precharge state	3	3
Idle state	4	4
Power track state	5	5
Reserved	6	6
Reserved	7	7
Reserved	8	8
Fault state	9	9
Initialization state	A	10
Disabled state	B	11
Latching fault state	C	12
Cool down state	D	13

The following table contains the bitmap information for the PVM status register . The response values for this command are shown in the table as both hex and decimal values. When multiple codes are set, the resulting status word value will be a sum of the individual code values.

Table 6-21. PVM status register status code values

Description	Hex Value	Decimal Value	Notes
Modbus register number = 42005			
OK	0	0	
Rebooting	1	1	
Inverter communication fault	2	2	Results in return value of zero for reads of data registers listed in Table 6-18 on page 6-25.
Web post fault	4	4	

Table 6-21. PVM status register status code values (Continued)

Description	Hex Value	Decimal Value	Notes
Modbus register number = 42005			
DNS server fault	8	8	
Real time clock error	10	16	The battery is dead or cannot synchronize with the network time server.
Wrong communications firmware	20	32	Incompatible or incorrect revision of communications firmware.
Modbus address error	40	64	Failed reading the Modbus address switches.

Modbus Command Registers

Table 6-22. Modbus command registers

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
Modbus base address = 3000						
Clear fault command	3000	3000	1	43001	UINT	Range = CF hex Write this value to clear faults and try a restart.

Table 6-22. Modbus command registers (Continued)

Description	Start Register	End Register	No. of Registers	Modbus Address	Data Type	Notes
Modbus base address = 3000						
Disable inverter	3001	3001	1	43002	UINT	Write values: • 0xDD to disable • 0xEE to enable Reading this register returns: • 0 after bootup • 0xDD after a disable • 0xEE after an enable command is sent
Enable inverter	3002	3002	1	43003	UINT	Write values: • 0xDD to disable • 0xEE to enable
Reset data comm section	3003	3003	1	43004	UINT	Write 0x99 to this register to reset the communication interface PCB.

Related Links

• "Troubleshooting Warnings and Faults" on page 8-2

Maintenance

WARNING:

These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions.

AVERTISSEMENT:

Ces instructions d'entretien sont destinées uniquement à un personnel qualifié. Pour réduire le risque d'électrocution, ne pas effectuer un entretien autre que celui spécifié dans les instructions de fonctionnement.

WARNING:

Maintenance personnel must receive proper training before installing, troubleshooting, or maintaining high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.

AVERTISSEMENT:

Le personnel d'entretien doit recevoir une formation appropriée avant d'installer, de dépanner ou d'entretenir un équipement électrique à haute énergie. Des tensions potentiellement mortelles pourraient provoquer la mort, des blessures graves ou des dommages à l'équipement. S'assurer que toutes les consignes de sécurité appropriées ont été respectées.

Routine maintenance of the AE inverter should be performed according the maintenance schedule in this manual in order to maintain the overall performance of the unit. Some maintenance procedures are required every five, ten, fifteen, and twenty years from point of installation.

The user manual includes maintenance procedures that you can perform without specialized equipment.

VISUAL INSPECTION

DANGER:

Risk of electrical shock. High voltages are present in the inverter cabinet. Both AC and DC disconnects must be in the OFF position when working on the unit. Wait five minutes to discharge high voltage before opening the front panels of the inverter.

DANGER:

Risque d'électrocution. L'intérieur de l'onduleur est soumis à des hautes tensions. Les interrupteurs de courant alternatif et continu doivent être mis HORS TENSION durant les travaux sur l'unité. Attendez cinq minutes afin de permettre la décharge du courant haute tension avant de démonter les panneaux avant de l'onduleur.

DANGER:

RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

DANGER:

RISQUE DE MORT OU DE BLESSURES CORPORELLES. Débrancher et verrouiller/étiqueter toutes les sources de puissance d'entrée avant de travailler sur cette unité ou sur tout élément qui y est raccordé.

AE recommends visually inspecting the inverter every time it is serviced. Start by observing the front, back, and sides of the inverter for damage, foreign objects, or dust and debris that may have accumulated around the inverter. Remove dirt and debris from the area around the inverter at least every six months.

MAINTENANCE SCHEDULE

The following maintenance should be performed annually by a qualified service person. Please refer to AE's Terms and Conditions of Sale for warranty-related items. Complete the maintenance checklist below save the information for your records.

Table 7-1. Maintenance checklist

Item #	Check or Procedure	Annual Maintenance
A	**General inspection and cleaning**	
1	Record general site conditions.	X
2	Record inverter performance data from inverter display.	X
3	Record environmental conditions.	X
4	Remove dirt and debris from underneath the inverter.	X
5	Inspect and clean interior of inverter.	X
6	Inspect air filter and clean or replace.	X
7	Inspect fans.	X
8	Confirm presence of product documentation.	X
B	**Connections and wiring**	
9	Complete visual inspection of electrical connections and wiring.	X
10	Complete mechanical inspection of connections and wiring.	X
11	Measure torque of all electrical connections and re-torque as needed.	X
12	Complete thermal scan of inverter connections, wiring and electronics.	X
C	**Testing**	
13	Confirm the inverter operating modes including standby, startup, and on.	X
14	Check operation of protective circuits and alarms.	X
15	Validate display data accuracy.	X
D	**Repair or replace**	
16	Repair or replace items that have been determined to be near the end of their useful life.	X
E	**Reporting**	
17	Complete the preventative maintenance report and recommendation.	X

REPLACEMENT PARTS

Contact Solar Energy Technical Support for information on obtaining replacement parts.

Table 7-2. Inverter replacement parts

Part	Replacement Schedule
Door seal gaskets	5 years
Battery (CR1216)	When a Real Time Clock error occurs in Modbus PVM status register 42005.
Air filters	As needed
Card cage filter	As needed

CHECKING AND REPLACING THE AIR FILTERS

As part of preventative maintenance, every 12 months you should perform regular checks of the self-contained cooling system to determine if the air filters need to be replaced. Cleaning may be required more often depending on the location of the inverter or the air filters might need to be replaced.

Maintaining the Air Filters

TOOLS REQUIRED

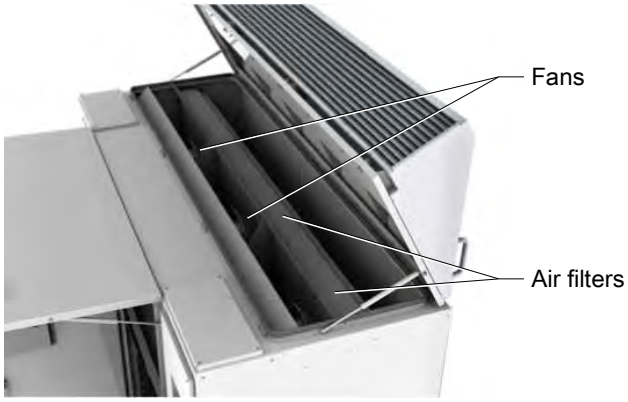
- Flat-head screwdriver
- 5/32″ Allen wrench

TO MAINTAIN THE AIR FILTERS

The air intake hood is mounted on gas shocks. The hood must be in the open position to clean the filters.

1. Shutdown the inverter prior to starting this procedure and wait five minutes.
2. Using a flat-head screwdriver, turn each of the four retainer tabs a three-quarter turn. The air intake hood can now be lifted to the open position.
3. Remove the filters using a 5/32″ Allen wrench.
4. Clean the filters by vacuuming or blowing out using an air hose with a diffuser.

   If there is significant accumulation of dust or particulate matter within the filter fabric, areas of visible blockage to air flow, or physical damage, replace the affected filters.



5. Inspect the filter frames for damage.

   Contact AE Solar Energy Technical Support if you wish to replace the filters.

6. Close and secure the hood before resuming normal operation of the unit.

Maintaining the Card Cage Air Filter

TO MAINTAIN THE CARD CAGE FILTER

The card cage features a secondary air filter to ensure long PCB life. The card cage air filter is located under the intake air shroud above the card cage located in the upper right compartment.

Use the following instructions to access the secondary air filter for the card cage.

1. Shutdown the inverter and wait five minutes prior to starting this maintenance procedure.
2. Remove the air intake shroud next to the power supplies. This will expose the air filter.

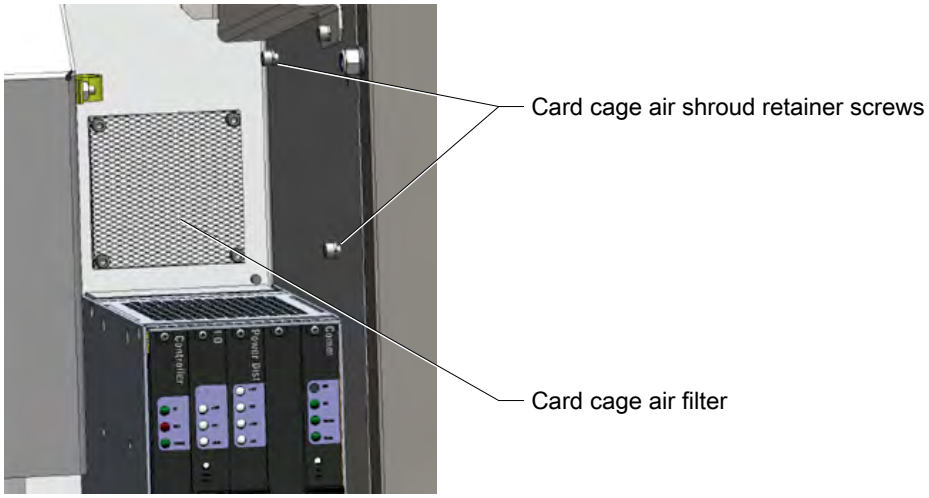


Figure 7-1. *Card cage air filter*

3. Remove the four screws on the card cage air filter.
4. Remove the filter.
5. Clean the filter with compressed air.
6. Replace the filter and secure with the screws.

   If the filter needs to be replaced, contact AE Solar Energy Technical Support.
7. Replace the shroud.

Troubleshooting and Solar Energy Technical Support

WARNING:

Maintenance personnel must receive proper training before installing, troubleshooting, or maintaining high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.

AVERTISSEMENT:

Le personnel d'entretien doit recevoir une formation appropriée avant d'installer, de dépanner ou d'entretenir un équipement électrique à haute énergie. Des tensions potentiellement mortelles pourraient provoquer la mort, des blessures graves ou des dommages à l'équipement. S'assurer que toutes les consignes de sécurité appropriées ont été respectées.

Before calling AE Solar Energy Technical Support, perform recommended checks and troubleshooting procedures. If you are still unable to resolve faults or warnings and resume normal operation after following these checks and procedures, contact AE Solar Energy Technical Support.

TROUBLESHOOTING LAN CONNECTIVITY

Most connectivity problems relate to wiring issues or corporate security settings blocking the inverter from accessing the Internet.

Wiring problems are usually caused by the following:

- Result of a poor crimp
- Wire that exceeds 320 ft. as specified in the installation of the inverter
- Pinched wires somewhere between the inverter and the hub or router

Corporate network problems will require support from your corporate IT department where the inverter is installed. The most common problem is the inverter has not been provided with DHCP server access using port 443 or the static IP address has not been set.

Troubleshooting communications issues can also be accomplished using the four LED lights on the communications PCB.

To Test the LAN Cable

AE recommends using pre-made cables whenever possible. If a cable must be hand-crimped, we recommend:

- Test the cable with a cable tester such as a Fluke LinkRunner™ Pro Network Multimeter (LPRO1000).
- Verify the cable's integrity by connecting a laptop to the cable at the inverter and verify it has access to the Internet.
- Verify the inverter's MAC address has been assigned an IP address by the network.

TROUBLESHOOTING WARNINGS AND FAULTS

WARNING:

Maintenance personnel must receive proper training before installing, troubleshooting, or maintaining high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.

AVERTISSEMENT:

Le personnel d'entretien doit recevoir une formation appropriée avant d'installer, de dépanner ou d'entretenir un équipement électrique à haute énergie. Des tensions potentiellement mortelles pourraient provoquer la mort, des blessures graves ou des dommages à l'équipement. S'assurer que toutes les consignes de sécurité appropriées ont été respectées.

DANGER:

This unit contains energy storage devices that take up to 5 minutes to discharge. Verify the high energy capacitors are completely discharged before working on this unit.

DANGER:

Cette unité contient des dispositifs de stockage d'énergie qui prennent jusqu'à 5 minutes pour se décharger. Vérifier que les condensateurs à haute énergie sont complètement déchargés avant de travailler sur l'unité.

The inverter's display screen is the primary indicator of a possible problem with the inverter. The inverter can detect and display inverter warnings and faults.

Before performing advanced troubleshooting, record the information provided on the display screen and de-energize the inverter.

Prior to conducting the following troubleshooting steps, perform a visual inspection to check for the following:

- Loose or disconnected wires
- Fuses
- Other connections
- Hardware issues

If the visual inspection reveals potentially unsafe conditions, discontinue troubleshooting and contact AE Solar Energy Technical Support or email invertersupport@aei.com prior to proceeding.

Troubleshooting Warnings

Warnings are displayed if a condition is detected that does not require the inverter to shut down but may require attention. The following screen is a sample warning screen.

Figure 8-1. *Warning screen*

SYSTEM WARNINGS

The following table lists the system warnings.

Table 8-1. Inverter system warnings

Hexadecimal Value	Display String	Description	Action
0001	FAN 1 WARNING	Fan 1 warning	Contact Solar Energy Technical Support
0002	FAN 2 WARNING	Fan 2 warning	
0008	MAG HITEMP WARNING	Magnetics high temperature warning	
0010	HI TEMP PWR LIMIT	Power foldback warning	
0020	DELTA TEMP WARNING	Heatsink delta temperature warning	
0080	GFDI CURRENT WARNING	GFDI current warning	
0100	AC SURGE WARNING	AC surge warning	
0200	DC SURGE WARNING	DC surge warning	
0400	DC CURRENT WARNING	Negative DC current warning	

Troubleshooting Inverter Faults

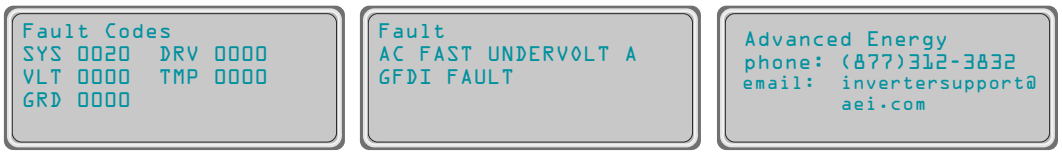
If a fault has occurred the inverter will cease power production until the fault is cleared. A fault may be a latching or non-latching fault.

- Non-latching: Automatically clears if the fault condition is resolved and the inverter automatically restarts after completing its startup sequence.
- Latching: Requires manual intervention to restart the inverter.

If the inverter has faulted, the display screen will show the corresponding fault information in a series of three or more screens. The display will then cycle back through the three screens.

- First screen: Displays the fault category followed by the hexidecimal fault code(s) value.
- Second screen: Displays a text description of the fault code(s).
- Third screen: Displays Solar Energy Technical Support contact information.

In the following example, a system fault, `SYS` returned a code, indicating too many fault restarts occurred. The `0000` indicates no fault occurred in the other fault groups.



Screen 1: Fault code(s) Screen 2: Fault text Screen 3: Contact information

Figure 8-2. *Screen sequence when an inverter faults*

AC UNDER VOLTAGE FAULT

To Identify an AC Under Voltage Fault

If the inverter displays an `AC Under Voltage` fault and all the voltages going into the inverter are within the tolerances provided in the specifications, continue with the following troubleshooting tips.

1. Check the main branch circuit breaker.

   a. If the breaker is not tripped:

      Check the small fuses located on the AC distribution PCB (there are nine in three sets of three). If one or more of these fuses have opened, replace them with like parts (600 VAC, 10 A or 20 A as required)

2. If any of the fuses are open, visually inspect the wiring. Look for the following:

   a. Frayed wires or carbon marks indicating a short

   b. Burned traces on the PCBs

   If any of these conditions are present, DO NOT START THE INVERTER. Contact AE Solar Energy Technical Support for replacement parts or service.

IDENTIFYING A GROUND FAULT

The inverter is equipped with a Ground Fault Detector Interrupter (GFDI). The purpose of the GFDI is to detect a ground fault (unintended current flow from the solar panels to earth ground) and in this event, disable the inverter.

WARNING:

For the GFDI circuit to function as designed, the solar array safety ground must not be connected to the PV array positive or negative leads. Bonding the safety ground to the grounded leg of the array anywhere but through the inverter will cause the GFDI circuit to be bypassed. This would defeat the operation of the GFDI and potentially create an unsafe operating condition.

AVERTISSEMENT:

Pour que le circuit GFDI fonctionne normalement, la prise de terre de sécurité du système PV ne doit pas être branché aux câbles positifs ou négatifs des piles PV. Brancher la prise de terre de sécurité au pied des piles ou à toute autre partie que l'onduleur causerait une mise hors circuit du GFDI. Ceci ne empêcherait le fonctionnement normale du circuit GFDI et créerait des conditions de fonctionnement potentiellement dangereuses.

The GFDI functions using a 5 A fuse to connect or bond the solar array negative (or the solar array positive, if using a positively grounded panel array) to earth ground on the DC distribution PCB.If the ground fault current exceeds 5 A between the grounded array terminal and the earth ground, the GFDI fuse will open and disconnect the solar panels from their ground reference, interrupting the ground fault. In this situation, the inverter will cease operation and show a ground fault message on the inverter display.

To Identify the Cause of a Ground Fault

1. Turn the ON/OFF switch on the display to the **OFF** position.
2. Turn the AC disconnect to the power OFF position.
3. Turn the DC disconnect to the power OFF position.
4. Identify the cause of the ground fault by checking the following items:
   a. A configuration error during commissioning.
   b. Switching the grounded conductor in the DC disconnect.
      - For a negatively grounded system, the positive leg should be broken in the DC disconnect.
      - For a positively grounded system, the negative leg should be broken in the DC disconnect.
   c. A pinched wire in the installation connecting some part of the array or DC wiring to earth ground.
   d. Mismatched array strings in a multiple inverter installation.
   e. An open GFDI fuse.

TO RESOLVE A GROUND FAULT

DANGER:

This unit contains energy storage devices that take up to 5 minutes to discharge. Verify the high energy capacitors are completely discharged before working on this unit.

DANGER:

Cette unité contient des dispositifs de stockage d'énergie qui prennent jusqu'à 5 minutes pour se décharger. Vérifier que les condensateurs à haute énergie sont complètement déchargés avant de travailler sur l'unité.

DANGER:

Verify that no shock hazard exists between both fuse terminals and earth ground before removing the fuse. A 600 V rated fuse pulling device is required.

DANGER:

Vérifier qu'il n'y a aucun risque d'électrocution entre les deux bornes de fusible et la prise de terre avant de retirer le fusible. Un arrache-fusible d'une capacité de 600 V est requis.

1. Open the DC side door and locate the DC distribution PCB.
2. Inspect the 5 A GFDI fuse for continuity using a multimeter.
3. Remove the GFDI fuse.
4. Check for continuity (ohms) across the GFDI fuse.

   If the meter indicates no continuity then a ground fault likely exists.

   - Check the DC voltage between the grounded terminal of the array and earth ground. The voltage should be less than 30 volts with the GFDI fuse removed. If the voltage is higher than 30 volts, a ground fault likely still exists. Check the array wiring. For the best results, perform this test with the DC disconnect in both the ON and OFF positions.
   - Make sure the grounded leg of the solar array is not disconnected in the DC disconnect.
5. Once the ground fault condition has been eliminated, verify the voltage between earth ground and the grounded side of the PV array is less than 30 volts.
6. Ensure the DC disconnect is in the OFF position and install the new GFDI fuse.
7. Restart the inverter.

If the ground fault cannot be eliminated, contact AE Solar Energy Technical Support.

Related Links

- "System Startup Procedure" on page 5-1

INVERTER FAULT CODES

The inverter display screen provides fault information. In addition, the inverter firmware utilizes a Modbus variable to indicate a fault condition. Each bit in this fault variable represents a fault type, the same fault type displayed on the screen. The Modbus information for the bit assignments and specific fault variables for the fault categories are as follows:

Table 8-2. Fault categories

Description	Screen Display Category	Bit Number	Hex Value	Decimal Value
Modbus register number = 42102				
Drive fault	DRV	0	1	1
Voltage fault	VLT	1	2	2
Grid fault	GRD	2	4	4
Temperature fault	TMP	3	8	8
System fault	SYS	4	10	16
Latching fault		15	8000	32768

For each fault category, another fault variable provides detailed information on which fault has occurred within this category. The following tables list the possible faults within each category and related information:

- Hexidecimal value: Value displayed following the category
- Screen display text: Text displayed on the second screen
- Description: Describes the fault
- Action: Necessary steps to resolve the fault

Drive Faults

The following table lists the drive protection faults.

Table 8-3. Drive (DRV) faults

Display Screen Hex Value	Display Screen Text	Description	Action
0001	DRIVE A LOW	Drive protection fault, phase A low	Contact Solar Energy Technical Support
0002	DRIVE A HIGH	Drive protection fault, phase A high	
0004	DRIVE B LOW	Drive protection fault, phase B low	
0008	DRIVE B HIGH	Drive protection fault, phase B high	
0010	DRIVE C LOW	Drive protection fault, phase C low	
0020	DRIVE C HIGH	Drive protection fault, phase C high	
0040	HW OVERCURRENT A	Peak over-current, phase A	
0080	HW OVERCURRENT B	Peak over-current, phase B	
0100	HW OVERCURRENT C	Peak over-current, phase C	
0200	RMS OVERCURRENT A	RMS over-current, phase A	
0400	RMS OVERCURRENT B	RMS over-current, phase B	
0800	RMS OVERCURRENT C	RMS over-current, phase C	
1000	DC OVERVOLTAGE	DC volts over range	
2000	DC UNDERVOLTAGE	DC volts under range	

Voltage Faults

The following table lists the voltage faults, including VAC sense, VDC, and power supply faults.

Table 8-4. Voltage (VLT) faults

Display Screen Hex Value	Display Screen Text	Description	Action
0001	VAC OVER PEAK A	Peak AC voltage high, phase A	Contact AE Solar Energy Technical Support.
0002	VAC OVER PEAK B	Peak AC voltage high, phase B	
0004	VAC OVER PEAK C	Peak AC voltage high, phase C	
0008	PLL FAULT	Control PLL fault	
0010	AC UNBALANCED FAULT	AC voltages unbalanced	
0020	DC OVER VOLTAGE	DC voltage high	
0040	POWER SUPPLY P5	5 V power supply fault	
0080	POWER SUPPLY P15	15 V power supply fault	
0100	POWER SUPPLY M15	-15 V power supply fault	
0200	POWER SUPPLY 10	10 V power supply fault	
0400	POWER SUPPLY 24	24 V power supply fault	
1000	DC PRECHARGE	DC precharge fault	
2000	PV-DC DELTA	PV input and DC bus voltage delta	

Grid Faults

The grid faults in the following table include grid interactive voltage and frequency faults.

Table 8-5. Grid (GRD) faults

Display Screen Hex Value	Display Screen Text	Description	Action
0001	AC FAST UNDERVOLT A	Fast AC voltage low, phase A	Wait for the grid to stabilize. The inverter cannot operate correctly when the grid voltage is out of range limitations or is unstable.
0002	AC FAST UNDERVOLT B	Fast AC voltage low, phase B	
0004	AC FAST UNDERVOLT C	Fast AC voltage low, phase C	
0008	AC SLOW UNDERVOLT A	Slow AC voltage low, phase A	
0010	AC SLOW UNDERVOLT B	Slow AC voltage low, phase B	
0020	AC SLOW UNDERVOLT C	Slow AC voltage low, phase C	
0040	AC FAST OVERVOLT A	Fast AC voltage high, phase A	
0080	AC FAST OVERVOLT B	Fast AC voltage high, phase B	
0100	AC FAST OVERVOLT C	Fast AC voltage high, phase C	
0200	AC SLOW OVERVOLT A	Slow AC voltage high, phase A	
0400	AC SLOW OVERVOLT B	Slow AC voltage high, phase B	
0800	AC SLOW OVERVOLT C	Slow AC voltage high, phase C	
1000	AC UNDER FREQ	Low frequency fault	
2000	AC OVER FREQ	High frequency fault	

Temperature Faults

The following table lists the temperature faults.

Table 8-6. Temperature (TMP) faults

Display Screen Hex Value	Display Screen Text	Description	Action
0001	HEATSINK TEMP A1	Module heat-sink A1 temperature high	Clean all filters. Make sure air vents aren't blocked and sufficient space is provided around all air vents. If the filters are clean and air flow is insufficient, contact AE Solar Energy Technical Support.
0002	HEATSINK TEMP A2	Module heat-sink A2 temperature high	
0004	HEATSINK TEMP B1	Module heat-sink B1 temperature high	
0008	HEATSINK TEMP B2	Module heat-sink B2 temperature high	
0010	HEATSINK TEMP C1	Module heat-sink C1 temperature high	
0020	HEATSINK TEMP C2	Module heat-sink C2 temperature high	
0040	BOARD TEMP HI	Control board temperature high	
0080	DRIVE TEMP LOW	Drive temperature low	
0100	MAGNETICS TEMP HI	Magnetics temperature high	
0200	AMBIENT TEMP LOW	Ambient temperature low	
0400	MAG TEMP LOW	Magnetics temperature low	
0800	IPM TEMP HIGH	IPM temperature high	

System Faults

The following table lists the miscellaneous system faults.

Table 8-7. System (SYS) faults

Display Screen Hex Value	Display Screen Text	Description	Action
0001	GROUND FAULT	Ground fault	Check the PV array field wiring.
0002	AC CONTACTOR	AC contactor fault	
0004	DC CONTACTOR	DC contactor fault	

Table 8-7. System (SYS) faults (Continued)

Display Screen Hex Value	Display Screen Text	Description	Action
0008	WD TIMER	Watchdog fault	Contact AE Solar Energy Technical Support for service.
0010	CPU LOAD	CPU load fault	
0020	RESTART LIMIT	Too many fault restarts	
0040	CONFIGURATION	Configuration fault	
0080	CURRENT IMBALANCE	AC current imbalance	
0100	AC VOLTAGE SENSE	No AC voltage detected	
0800	DISCONNECT OPEN	Disconnect open	Check the DC wiring.
1000	DC MISWIRE	DC mis-wired for configured grounding	

PCB STATUS LEDS

The AE commercial inverter includes status LEDs to help troubleshoot system operation. The status LEDs are located on the following PCBs:

- Controller PCB
- Communications interface PCB

Controller PCB Status LEDs

There are two LEDs on the front of the controller PCB, a green and a red LED.

Table 8-8. Controller PCB LEDs

LED Color	Flash Code	LED Sequence / Unit Status	Action
Green	Solid	Inverter is on and ready to produce power.	None

Table 8-8. Controller PCB LEDs (Continued)

LED Color	Flash Code	LED Sequence / Unit Status	Action
Red	Solid	The inverter is in a faulted condition.	• Check the fault code on the display screen • Clear the fault condition • Inverter will auto reset
	Flashing	A latching fault has occurred.	• Check the fault code on the display screen • Manually clear the fault condition • Restart the inverter

Communication PCB Status LEDs

The communication PCB includes four status LEDs.

- Link: Indicates presence of a hardware Ethernet connection
- Activity (or ACT): Indicates internet traffic
- Status: Indicates the communication status
- Modbus: Indicates activity on the Modbus network

The four LEDs primary location is on the face of the communication PCB in the card cage on the right side of the power module assembly as shown in the following figure.

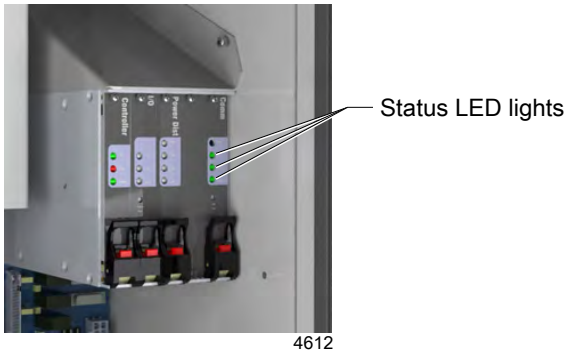


Figure 8-3. Communication PCB with status LEDs

The other set of LEDs are on the communication interface PCB located in the data monitoring section in the front upper right of the inverter. These four LEDs are surface mount LEDs located near the Ethernet and Modbus connector as shown in the following figure. These LEDs are redundant and are synchronized with communication PCB.

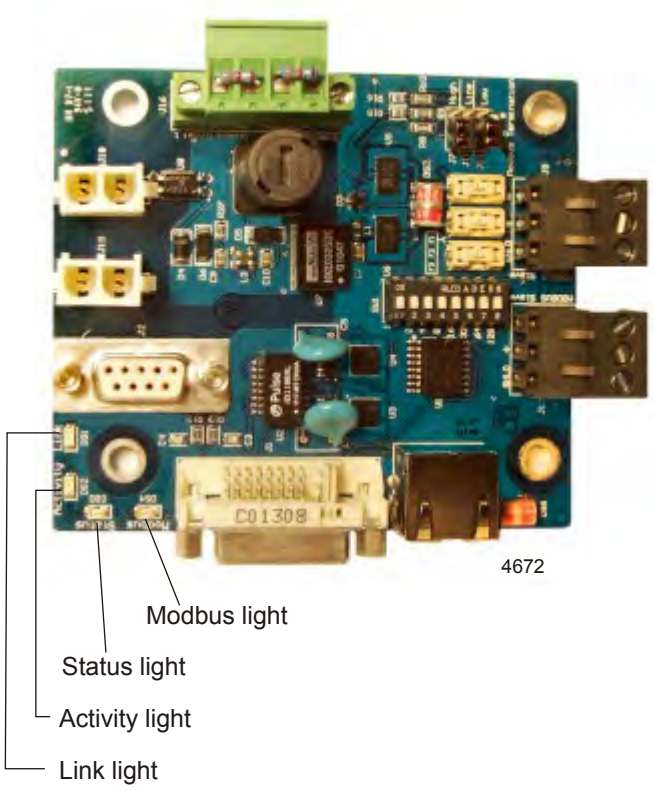


Figure 8-4. *Communication interface PCB with LEDs*

Table 8-9. *Link LED*

LED Color	Flash Code	Unit Status / Description	Action
Amber	On	Hardware Ethernet connection is found	None
	Off	No hardware Ethernet connection available	None

Table 8-10. *Activity LED*

LED Color	Flash Code	Unit Status / Description	Action
Green	Flashes	Continuous flash to indicate the presence of internet traffic	None
	Solid	May be solid in the presence of heavy internet traffic	None

Table 8-11. Status LED

LED Color	Flash Code	Unit Status / Description	Action
Green	On	Serial communication is established. Inverter communications are operating normally. • On solid for a few seconds • Followed by quick flashes for several seconds while the communications device looks for an Internet connection • After a few seconds flashes more slowly while serial communication is established with the inverter's main processor • Remains on unless a fault occurs	None
	Short-long-short	Serial communication fault. The communication PCB is communicating with the inverter's main processor via serial communication. If the communication PCB cannot establish communication with the main processor, the serial communication fault code will flash. It is normal for this status code to flash for a few seconds during startup.	None
	Long-short-short	DNS failure. The inverter attempts to post data once every 15 minutes to the AE database using Domain Name Service (DNS) server to resolve the IP address. The DNS failure code will flash when: • DNS server cannot be found • Invalid IP address returned If this post succeeds, the LED returns to normal operation until the next post attempts to connect to the DNS server.	• Verify the IP address is valid.

Table 8-11. Status LED (Continued)

LED Color	Flash Code	Unit Status / Description	Action
	Short-Short-Long	Network connection fault. The inverter cannot post data to the AE database server. The status LED may indicate normal operation before this occurs. This can happen in the following circumstances: • Network cable is not connected • Network does not have a DHCP server or the DHCP server did not provide a valid IP address to the inverter • AE server is down for maintenance • Any other network problem that does not allow data to post to the AE server	• Verify network cable is connected. • Verify the IP address is valid.

Table 8-12. Modbus LED

LED Color	Flash Code	Unit Status / Description	Action
Green	Short (1/8 sec.)	Enables the installer to troubleshoot the system by verifying that communications are occurring on the network, indicating the following: • If the inverter is connected as a slave device, the LED flashes quickly whenever there is activity on the network • Modbus network commands occurring but are not addressed to this specific inverter	• Check the Modbus address switches and make sure they correspond to the address programmed into the Modbus master. • Confirm that the baud rate and other communication parameters of the Modbus master are set correctly.
	Long (1/2 sec.)	Inverter sees and responds to a Modbus master request message that is addressed to this specific inverter.	None
	Short and long	Communication occurring on a Modbus network that contains multiple Modbus slave devices.	None

AE SOLAR ENERGY TECHNICAL SUPPORT

Please contact AE Solar Energy Technical Support if you have questions or problems that cannot be resolved by working through the provided troubleshooting. When you call Solar Energy Technical Support, make sure to have the unit serial number and part number. These numbers are available on unit labels.

Table 8-13. AE Solar Energy Technical Support 24 X 7 contact information

Office	Contact
AE Solar Energy Technical Support 20720 Brinson Blvd Bend, OR 97701 USA ☞ **Important** For returns and repairs, please call Solar Energy Technical Support to request an RMA and obtain the correct shipping address.	Phone (24 hrs/day, 7 days/week): Inside the U.S., call 877.312.3832 or Outside the U.S., call +1.541.323.4143 Email: (We will respond to email by the next business day.) invertersupport@aei.com
If you would prefer to contact a local or regional sales or service office, visit the Advanced Energy web site for current contact information (click on Sales and Support): • http://www.advanced-energy.com	

Specifications

PHYSICAL SPECIFICATIONS

Table 9-1. Physical specifications

Description	Specification
General Physical Specifications	
Enclosure rating	NEMA 4
Construction	Powder-coated steel with hot-dipped zinc base
Size	9375 mm (H) x 2512 mm (W) x 1052 mm (D) 93.5″ (H) x 98.9″ (W) x 41.4″ (D)
Maximum weight	2268 kg (5000 lb)
User Interface and Communications Protocol	
Display	VFD 4 rows x 20 characters
RS-485	Screw terminal block
Ethernet	IP over Ethernet

ELECTRICAL SPECIFICATIONS

The table lists electrical specs for the following inverter models:

- PVP250kW (480 VAC)
- PVP250kW (600 VAC)
- PVP260kW (480 VAC)
- PVP260kW-LV (480 VAC)

Note the following limits:

- Accuracy limit of voltage and energy production measurements: ± 5%
- Accuracy limit of frequency measurement: ± 0.1 Hz

Table 9-2. Electrical specifications

Description	Specification
AC Characteristics	
Continuous AC power	PVP250kW: 249.5 kW PVP260kW and PVP260kW-LV models: 260 kW
Grid type	Three phase, four wire wye (not compatible with delta service)
Nominal AC voltage (VAC)	480 VAC models: 480 wye 600 VAC models: 600 wye
Maximum output fault current and duration Note 1	PVP250kW: 336 A rms at 208 VAC, 29 ms PVP260kW and PVP260kW-LV models: 336 A rms at 480 VAC, 29 ms PVP260kW and PVP260kW-LV models: 269 A rms at 600 VAC, 29 ms
Maximum utility backfeed current	PVP250kW: 593 A PVP260kW and PVP260kW-LV: 593 A
AC maximum continuous current	PVP250kW 480 VAC: 304 A, 600 VAC: 243 A PVP260kW and PVP260kW-LV: 316 A
CEC efficiency	PVP250kW 96.5% PVP260kW: 97.0% PVP260kW-LV-LV: 96.5%
Peak efficiency	PVP250kW: 97.7% PVP260kW: 97.7%
Frequency range	59.3 Hz to 60.5 Hz
AC voltage range set points (default)	(–12% to +10%)
AC operating range	480 VAC models: 423 VAC to 528 VAC 600 VAC models: 528 VAC to 660 VAC
Power factor at full power	> 0.99
Total harmonic distortion	< 3%
Standby losses	PVP250kW: < 90 W (600VAC), < 67 W (480VAC) PVP260kW and PVP260kW-LV: 67 W
DC Characteristics	
DC input bus bar rating	1600 A
Maximum operating input current	PVP250kW: 890 A PVP260kW: 925 A PVP260kW-LV: 1030 A

Table 9-2. Electrical specifications (Continued)

Description	Specification
MPPT range Note 2	PVP250kW and PVP260kW: 295 V to 595 V PVP260kW-LV: 265 V to 595 V
Maximum voltage at open circuit	600 V_{OC}
Startup voltage	PVP250kW and PVP260kW: :330 V PVP260kW-LV model: 300 V
Startup power	PVP250kW: 1800 W PVP260kW and PVP260kW-LV models: 1800 W
Note 1 Information also known as the maximum fault current contribution. Note 2 At unity power factor and nominal AC voltage.	

Table 9-3. Utility interconnect voltage and frequency trip limits and times

Voltage and Frequency Trip Limits and Times			
The default trip limits and times meet UL1741 anti-islanding requirements. Voltage trip limit field adjustment range as a percentage of nominal: –12% to +10% Accessible range of frequency trip times: 0.16 s to 300 s Accessible range of low frequency setting (Hz): • Adjustable low trip 57.5-59.8 Hz • High trip fixed at 60.5 Hz (The accuracy limit of time measurement is ± 0.1 s.)			
480 VAC Configurations			
Condition	**Factory Setting (VAC)**	**Range (VAC)**	**Default Trip Time (seconds)**
Voltage phase high	304.8	304.8 to 332.5	1.0
Voltage phase low	243.9	216.1 to 243.9	2.0
Voltage phase fast high	332.5	332.5	0.16
Voltage phase fast low	138.6	138.6	0.16
600 VAC Configurations			
Condition	**Factory Setting (VAC)**	**Range (VAC)**	**Default Trip Time (seconds)**
Voltage phase high	381.1	381.1 to 415.7	1.0
Voltage phase low	304.8	270.2 to 314.8	2.0
Voltage phase fast high	415.7	415.7	0.16
Voltage phase fast low	173.2	173.2	0.16

Table 9-3. Utility interconnect voltage and frequency trip limits and times (Continued)

Voltage and Frequency Trip Limits and Times			
Frequency Trip Limits and Times			
Condition	**Factory Setting (Hz)**	**Range (Hz)**	**Maximum Trip Time (seconds)**
Line frequency low	59.3	57.5 to 59.8	0.16
Line frequency high	60.5	60.5	0.16

Efficiency Specifications

EFFICIENCY CURVES FOR THE PVP250KW (480 VAC) MODEL

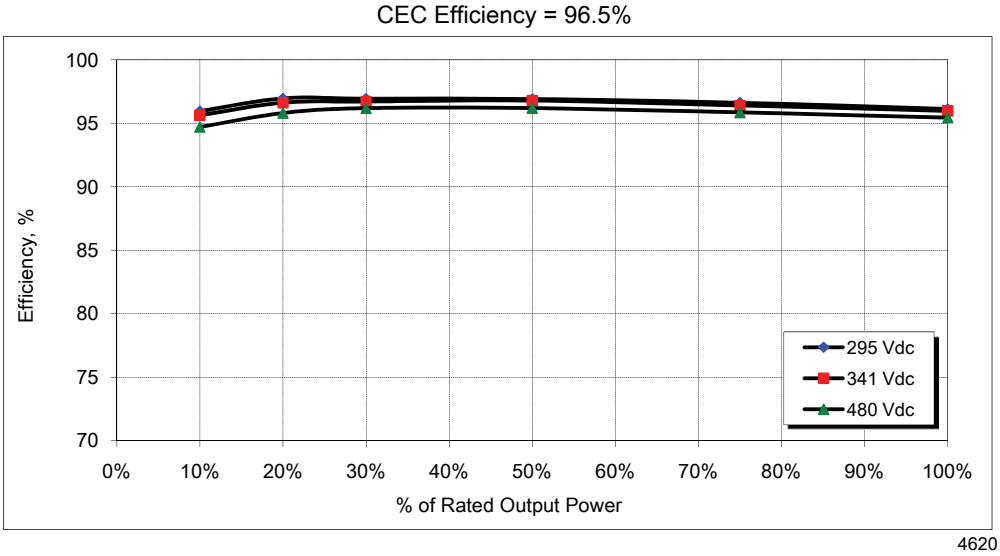


Figure 9-1. Efficiency curves for the PVP250kW (480 VAC) model

Table 9-4. Efficiency specifications for the PVP250kW (480 VAC) model

Input Voltage (VDC)		Power Level in Percent and kW						Weighted
		10% 24.95	20% 49.90	30% 74.85	50% 124.75	75% 187.13	100% 249.50	
V_{MIN}	295	96.0	97.0	96.9	96.9	96.6	96.1	96.7
V_{NOM}	341	95.6	96.6	96.7	96.8	96.4	96.0	96.5
V_{MAX}	480	94.7	95.8	96.2	96.2	95.9	95.4	95.9

EFFICIENCY CURVES FOR THE PVP250KW (600 VAC) MODEL

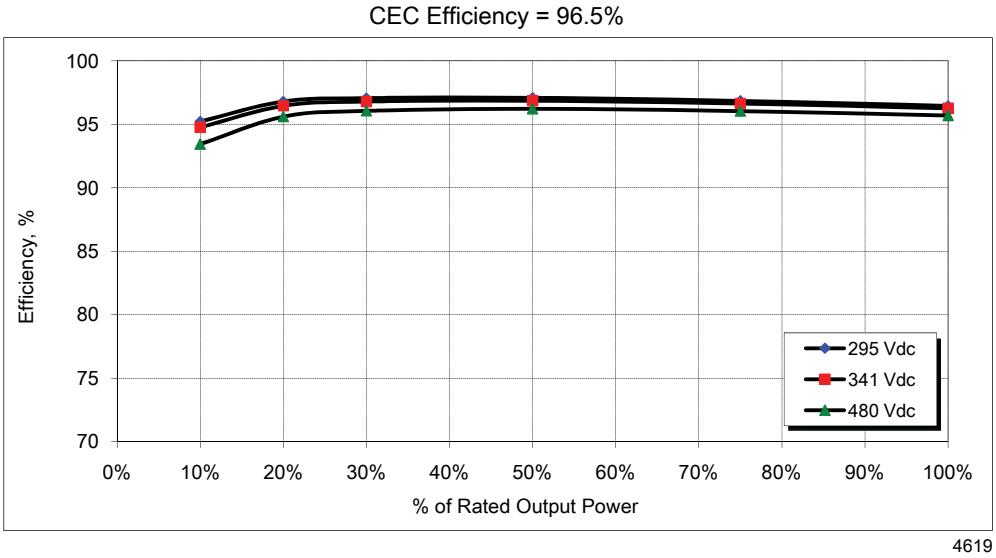


Figure 9-2. *Efficiency curves for the PVP250kW (600 VAC) model*

Table 9-5. *Efficiency specifications for the PVP250kW (600 VAC) model*

Input Voltage (VDC)		Power Level in Percent and kW						Weighted
		10% 24.95	20% 49.90	30% 74.85	50% 124.75	75% 187.13	100% 249.50	
V_{MIN}	295	95.2	96.8	97.1	97.1	96.8	96.4	96.8
V_{NOM}	341	94.8	96.5	96.8	96.9	96.6	96.3	96.6
V_{MAX}	480	93.4	95.6	96.1	96.2	96.0	95.7	95.9

EFFICIENCY CURVES FOR THE PVP260KW (480 VAC) MODEL

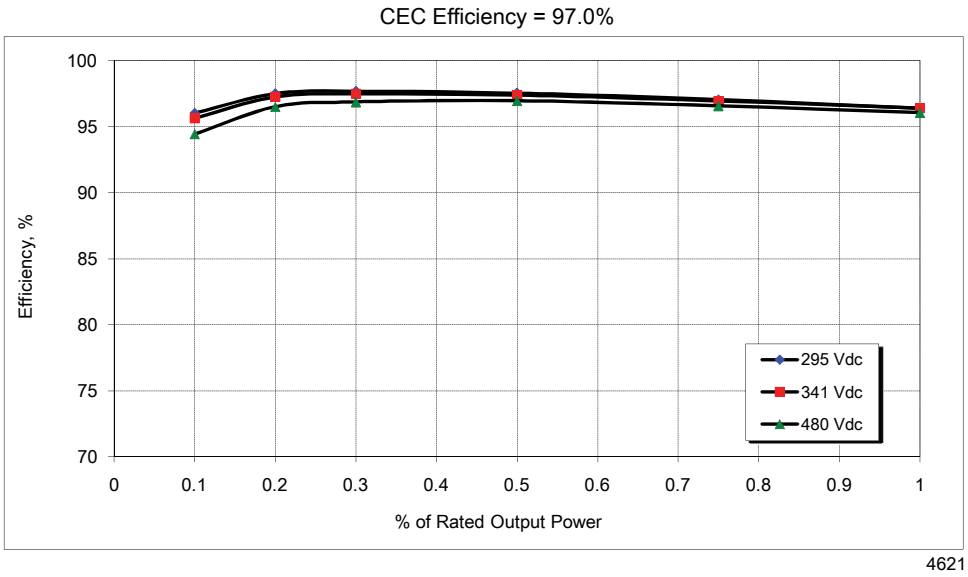


Figure 9-3. *Efficiency curves for the PVP260kW (480 VAC) model*

Table 9-6. *Efficiency specifications for the PVP260kW (480 VAC) model*

Input Voltage (VDC)		Power Level in Percent and kW						Weighted
		10% 26.00	20% 52.00	30% 78.00	50% 130.00	75% 195.00	100% 260.00	
V_{MIN}	295	96.0	97.5	97.7	97.6	97.1	96.4	97.2
V_{NOM}	341	95.6	97.3	97.5	97.4	97.0	96.4	97.0
V_{MAX}	480	94.4	96.5	96.9	97.0	96.6	96.1	96.6

EFFICIENCY CURVES FOR THE PVP260KW-LV (480 VAC) MODEL

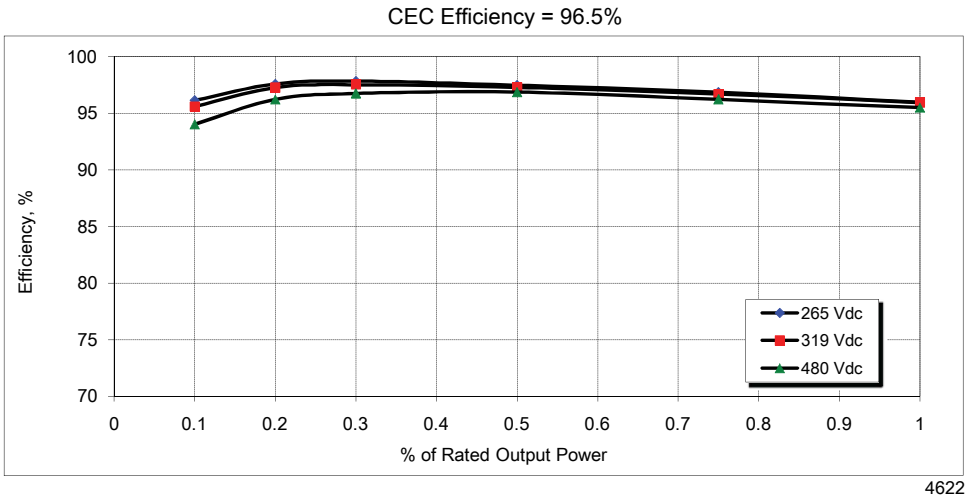


Figure 9-4. *Efficiency curves for the PVP260kW-LV (480 VAC) model*

Table 9-7. *Efficiency specifications for the PVP260kW-LV (480 VAC) model*

Input Voltage (VDC)		Power Level in Percent and kW						Weighted
		10% 26.00	20% 52.00	30% 78.00	50% 130.00	75% 195.00	100% 260.00	
V_{MIN}	295	96.1	97.6	97.8	97.5	96.9	96.0	97.1
V_{NOM}	341	95.6	97.3	97.5	97.3	96.7	95.9	96.9
V_{MAX}	480	94.0	96.2	96.7	96.8	96.2	95.5	96.3

COOLING SPECIFICATIONS

Table 9-8. *Cooling specifications*

Description	Specification
Cooling method	Forced convection
Maximum heat rejection rate	41,000 BTU/hr
Maximum fan air flow rate	28 liters per second (2300 CFM)

ENVIRONMENTAL SPECIFICATIONS

Table 9-9. Environmental specifications

Equipment Status	Temperature	Relative Humidity	Air Pressure
Operating	–30°C to +50°C –22°F to +122°F	0% to 95% non-condensing	Minimum air pressure = 81.2 kPa (812 mbar) Equivalent altitude = 1829 m (6000′)
Standby/Storage	–40°C to +60°C –40°F to +140°F	0% to 95% non-condensing	

System and Mechanical Diagrams

SYSTEM DIAGRAM

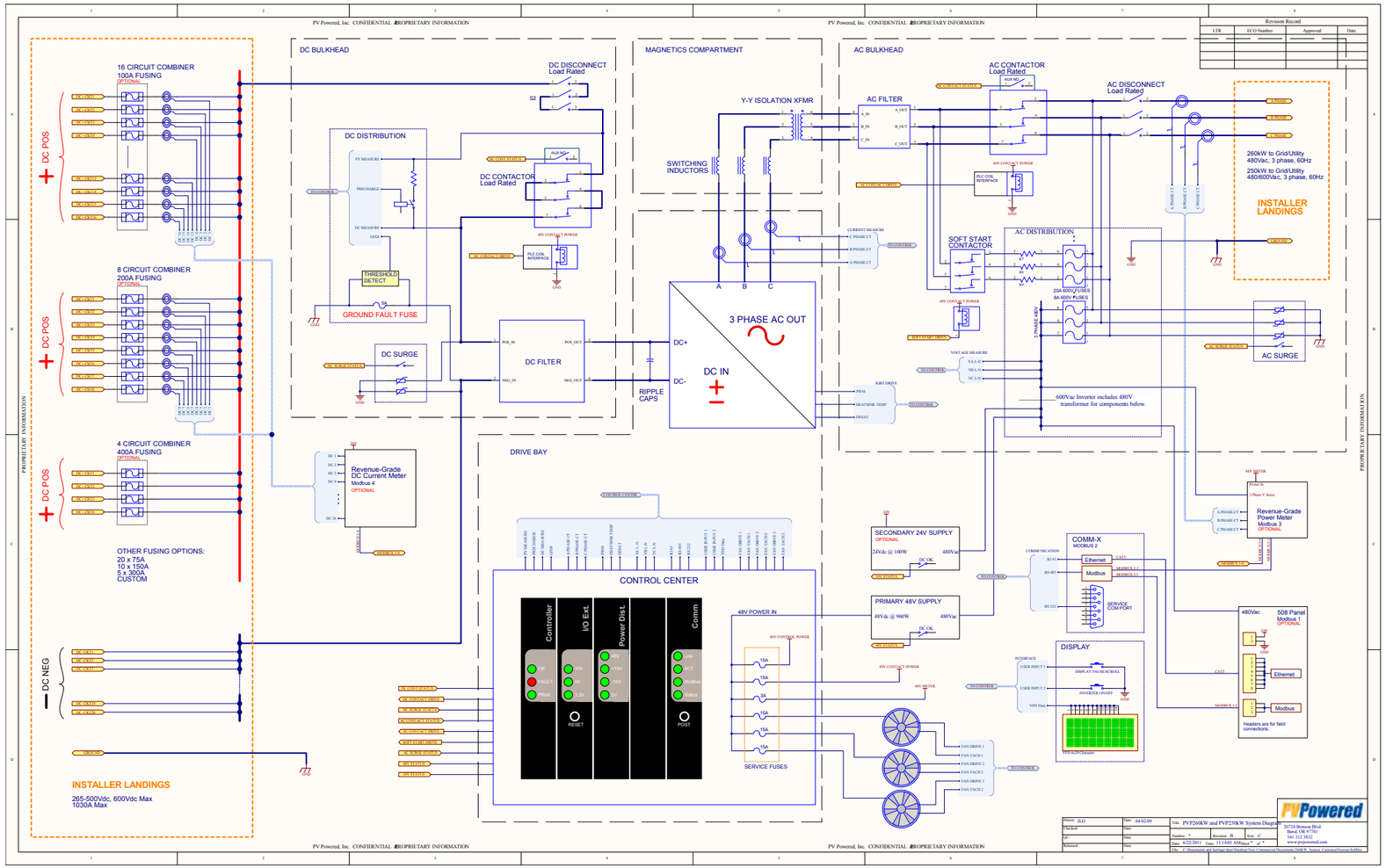


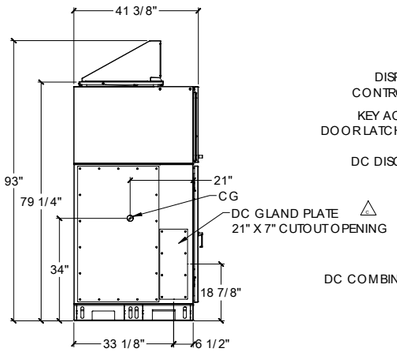
Figure 10-1. *PVP250kW and PVP260kW system diagram*

MECHANICAL DIAGRAMS

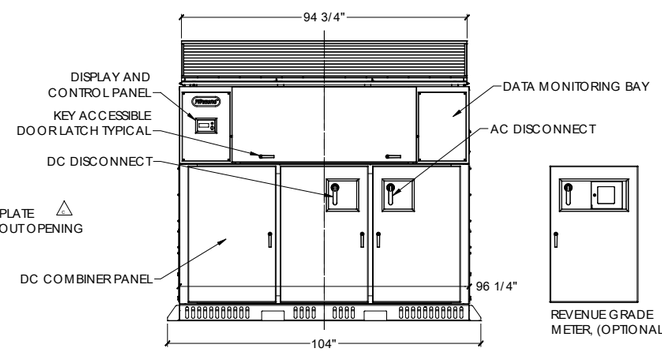
REVISION HISTORY			
REV.	DESCRIPTION	DATE	APPROVED
A.01	MANUFACTURING RELEASE	5/7/2009	AEO
A.02	ADDED DIMENSION FOR SIDE GLAND PLATE FROM BACK ADDED SIESMIC OPTION NOTE.	11/20/2009	AEO
B.01	UPDATED CABINET ASSEMBLY TO THE LATEST REVISION, UPDATED REBAR.	11/9/2010	AEO
C	UPDATED GLAND PLATE NOTES.	8/4/2011	JLR

NOTES:

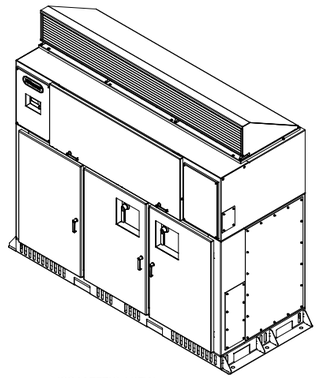
1. GENERAL MATERIAL: MILD STEEL.
2. GENERAL FINISH: POWDER COAT, RAL 7038.
3. NEMA RATING: 4
4. APPROXIMATE WEIGHT: 4800LBS.
5. PROVIDE WORKING CLEARANCES PER NEC 110.26.



LEFT SIDE VIEW



FRONT VIEW



ISOMETRIC VIEW

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.XXX ± .010

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TITLE
INSTALLATION SPECIFIC ENCLOSURE DETAIL, 260kW INVERTER

SIZE	PART NO.	REV.
B	60-600018-01	C

SCALE 1:30 CALC. WT ACT. WT SHEET 1 OF 4

Figure 10-2. *PVP250kW and PVP260kW mechanical diagrams: View 1*

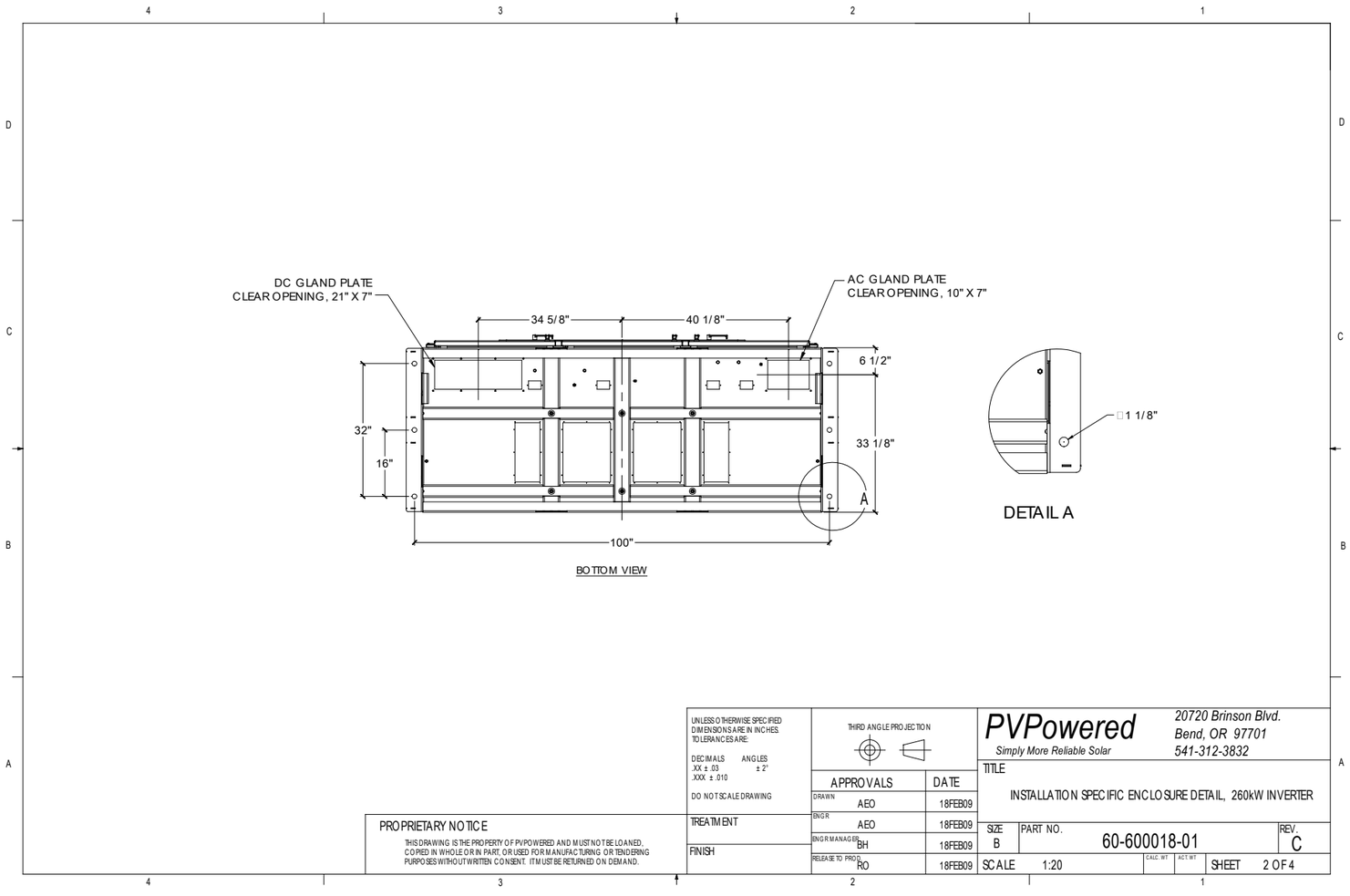


Figure 10-3. *PVP250kW and PVP260kW mechanical diagram: View 2*

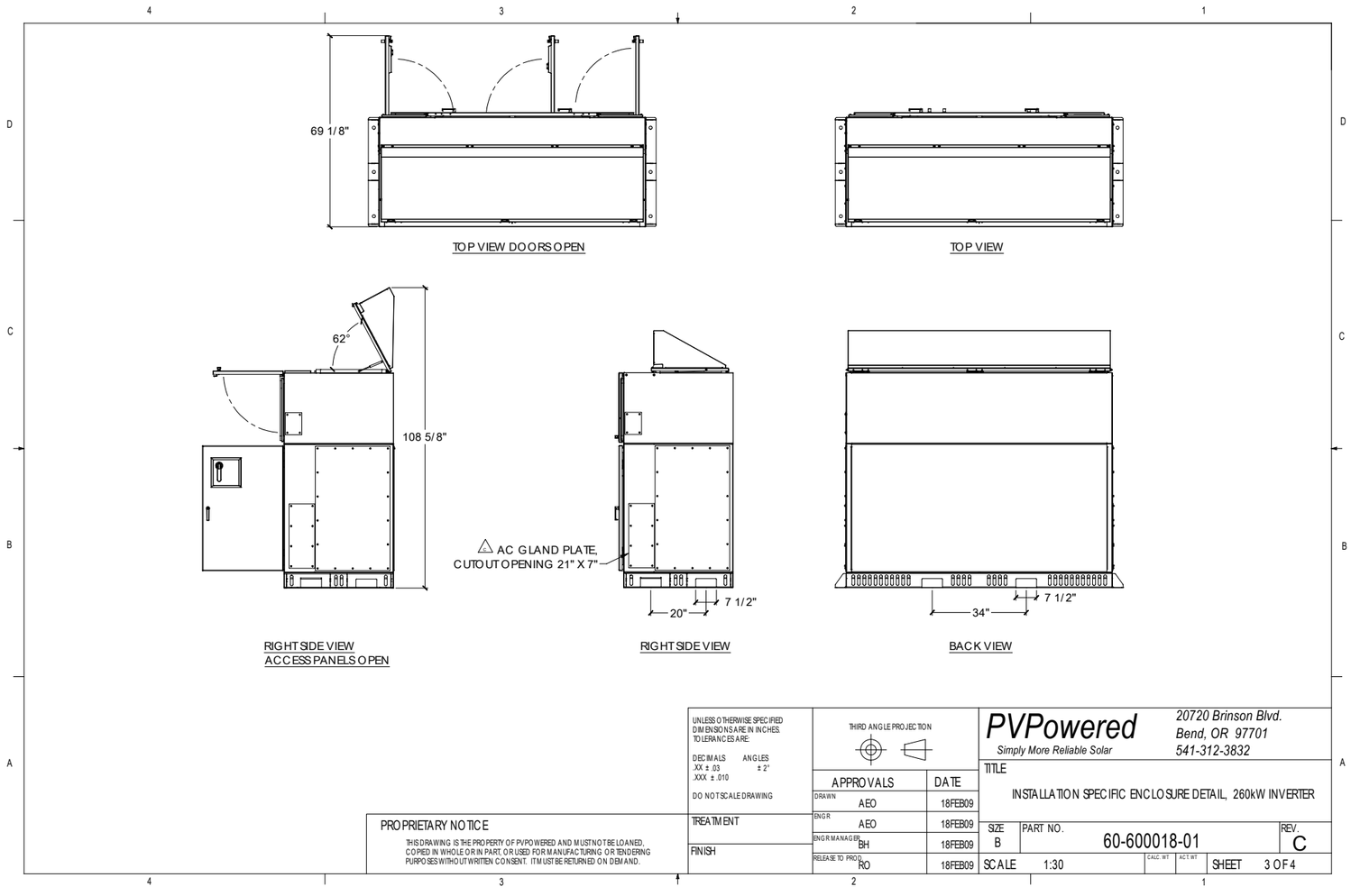
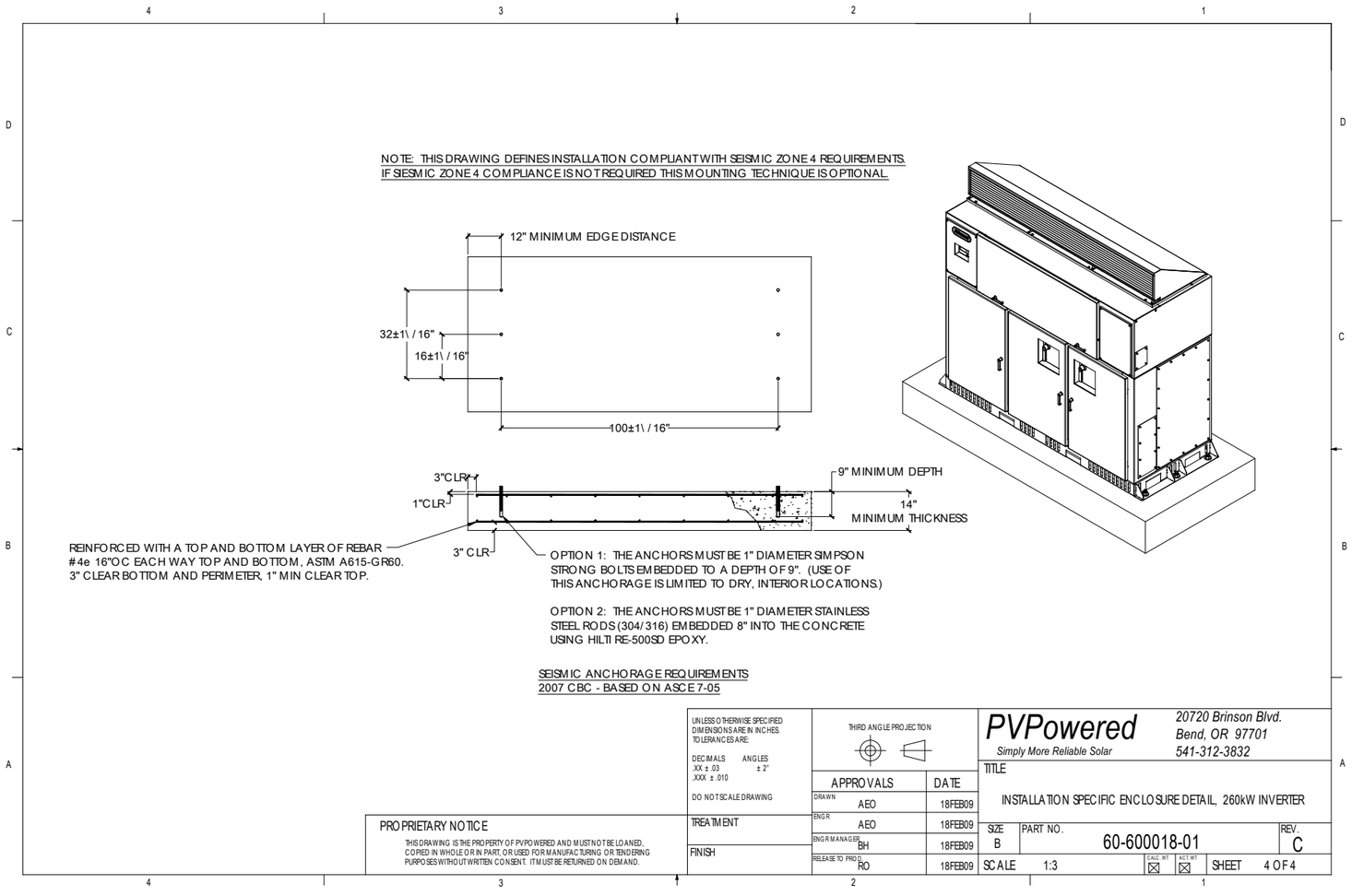


Figure 10-4. *PVP250kW and PVP260kW mechanical diagram: View 3*


NOTE: THIS DRAWING DEFINES INSTALLATION COMPLIANT WITH SEISMIC ZONE 4 REQUIREMENTS.
IF SIESMIC ZONE 4 COMPLIANCE IS NOT REQUIRED THIS MOUNTING TECHNIQUE IS OPTIONAL.
12" MINIMUM EDGE DISTANCE
32±1\ / 16"
16±1\ / 16"
100±1\ / 16"
3"CLR
1"CLR
3" CLR
9" MINIMUM DEPTH
14"
MINIMUM THICKNESS
REINFORCED WITH A TOP AND BOTTOM LAYER OF REBAR
#4e 16"OC EACH WAY TOP AND BOTTOM, ASTM A615-GR60.
3" CLEAR BOTTOM AND PERIMETER, 1" MIN CLEAR TOP.
OPTION 1: THE ANCHORS MUST BE 1" DIAMETER SIMPSON
STRONG BOLTS EMBEDDED TO A DEPTH OF 9". (USE OF
THIS ANCHORAGE IS LIMITED TO DRY, INTERIOR LOCATIONS.)
OPTION 2: THE ANCHORS MUST BE 1" DIAMETER STAINLESS
STEEL RODS (304/316) EMBEDDED 8" INTO THE CONCRETE
USING HILTI RE-500SD EPOXY.
SEISMIC ANCHORAGE REQUIREMENTS
2007 CBC - BASED ON ASCE 7-05
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INSTALLATION SPECIFIC ENCLOSURE DETAIL, 260kW INVERTER
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PART NO. 60-600018-01
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Figure 10-5. *PVP250kW and PVP260kW mechanical diagram: View 4*

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